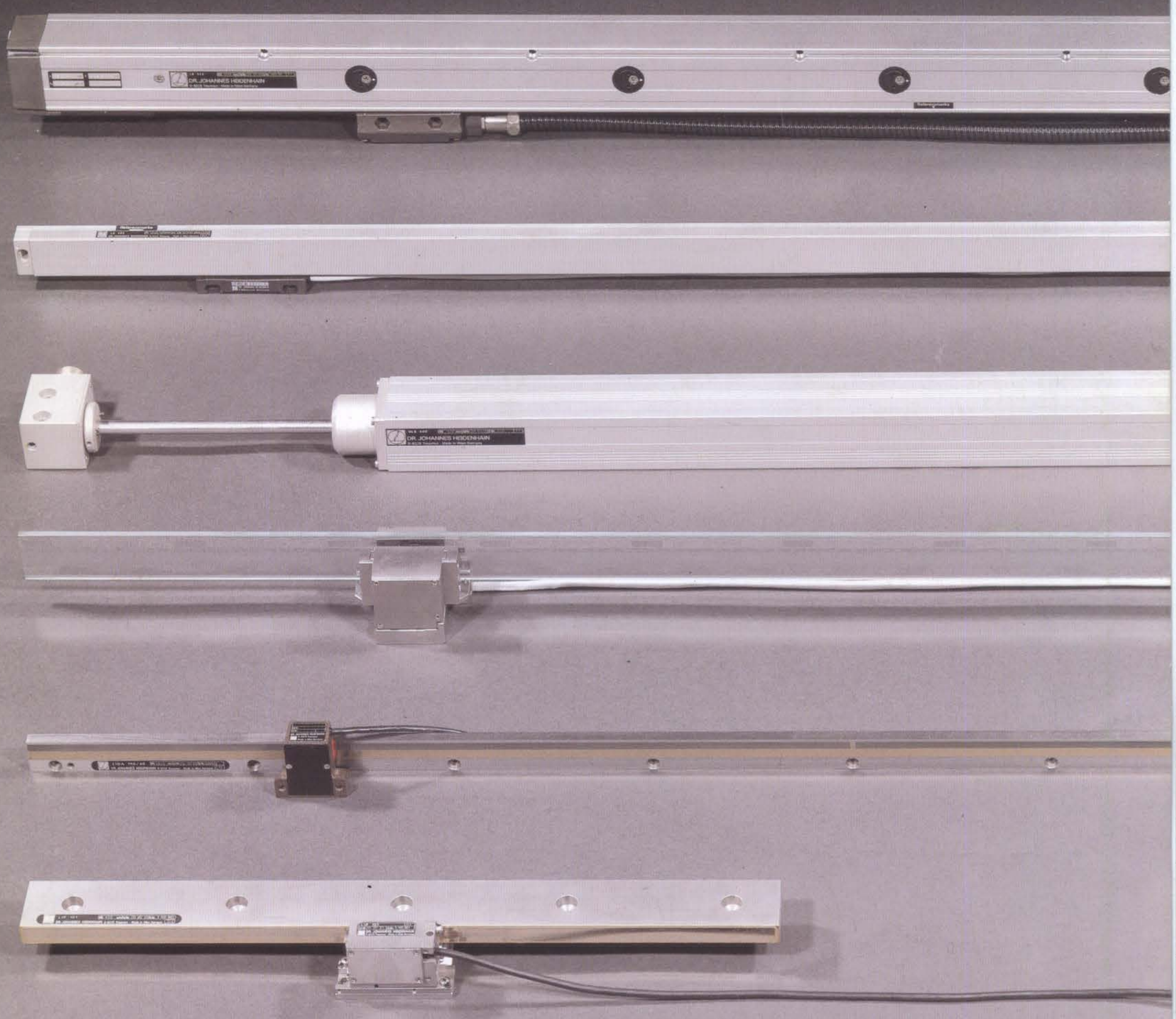
NC-Linear Encoders



November '88

HEIDENHAIN

Голоменко Ю. П
6-04

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DR. JOHANNES HEIDENHAIN GmbH
Traunreut, West Germany

Aerial Photo by Bertram, Munich-Riem
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The history of the company is based on the manufacture of precision graduations – linear scales, angular scales, reticles etc.
In 1889 Wilhelm Heidenhain, a young mechanic, founded a metal etching company in Berlin. In the following decades it grew into the largest of its kind in Europe. In 1923 Dr. Johannes Heidenhain joined his father's enterprise. The first major step was in 1928 when HEIDENHAIN developed the lead sulphide (METALLUR) process for making exact copies of master graduations.
In 1948, after the destruction and loss of its plants in Berlin, Suhl (East Germany) and Gars (Austria) the company was re-established under the name of DR. JOHANNES HEIDENHAIN in Traunreut, Bavaria. A pioneer achievement was the new DIADUR copying process for the production of highly durable precision graduations (1950).

The company grew steadily. Optical projection measuring devices (for machine tools, rotary tables, measuring and test equipment) were developed; the display of the complete measurement value as a number (down to 0.001 mm or 1 angular second) was a HEIDENHAIN innovation.
. For over 25 years HEIDENHAIN has been supplying digital electronic linear and angle measuring systems for machine tools, precision equipment and instrumentation,
. for over 20 years digital readouts for machine tools and
. for over 10 years shop-floor-programmable numerical controls for milling machines.
Some 2450 people work in the HEIDENHAIN sales and production facilities – over 200 of whom are devoted to research and development.

Contents

General Notes

Lengths, distances, traverses or positions can either be measured with a scale, i. e. directly, or indirectly e. g. via a time measurement.
The standard "meter" was defined in 1983 by an indirect measurement as being "the distance that a light wave travels within a vacuum during a time interval of 1/299 792 458 second".
Linear measuring systems can be categorized by the type of measuring standard being used or the physical measuring principle, respectively:
. graduated scales
. photoelectrically scanned line gratings and phase gratings
. scales with cyclically variable magnetic zones and magnetic scanners
. Inductosyn scales (induction based measuring signals)
. capacitive measuring standards
. mechanical measuring standards (racks or ballscrews)
. laser interferometers
. gage blocks
and others.

The **photoelectric measuring principle** distinguishes itself from other principles (with exception of laser interferometers) by scanning scales with relatively wide graduations as well as with very fine graduations as measuring standards. The grating period (the distance from the forward edge of one line to the next) of a HEIDENHAIN linear encoder can be e. g. 8 µm, 10 µm, 20 µm, 40 µm or 100 µm.

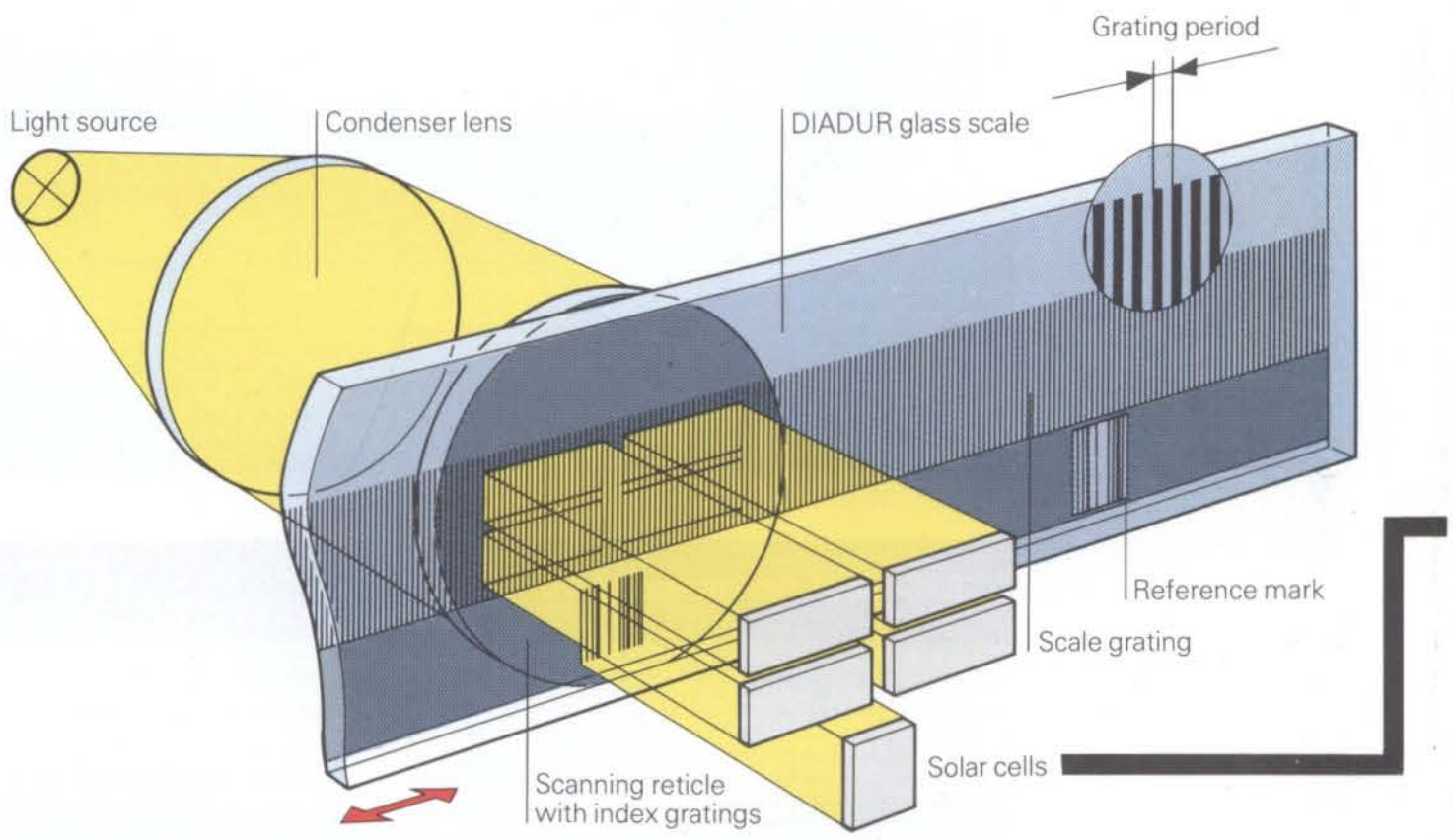
Rotary encoders in conjunction with mechanical measuring standards such as ball screws or racks can also measure linear movements (see "HEIDENHAIN Rotary Encoders" overview ≤ 5000 lines, pp. 50 . . . 51).

For rotary encoders employed as measured value sensing units for position determination on rotary axes see "HEIDENHAIN Angle Encoders" overview ≥ 6000 lines, pp. 52 . . . 53.

Photoelectric Scanning of Incremental Encoders

HEIDENHAIN linear encoders of the **LS and LID construction**, for example, contain a glass scale with a **line grating** applied with the DIADUR-process. The scale grating produced by the DIADUR-process consists of opaque lines and transparent spaces of equal width. One or more reference marks constitute a second track. The **scanning unit** is comprised of a light source, a condenser lens for collimating the light beam, the scanning reticle with the index gratings and silicon solar cells.

When the scale is moved relative to the scanning unit, the lines and spaces of the scale alternately coincide with those of the index gratings. The corresponding fluctuations of the light are sensed by the solar cells, which generate two sinusoidal output signals I_{e1} and I_{e2} and a reference mark signal I_{e0}. Signals I_{e1} and I_{e2} of approx. 10 μA_{pp} are phase-shifted by 90° el.



Photoelectric scanning of a DIADUR glass scale

Linear encoders of the **LIDA and LB construction** operate on the same principle. They contain steel scales with AURODUR line gratings consisting of highly reflective gold lines and mat etched gaps. The light source and the scanning unit are next to one another.

The **LIP 101** is based on quite a different conception. The scale of the LIP 101 is a reflective type diffraction grating. Two sinusoidal output signals with 4 µm cycle are provided.

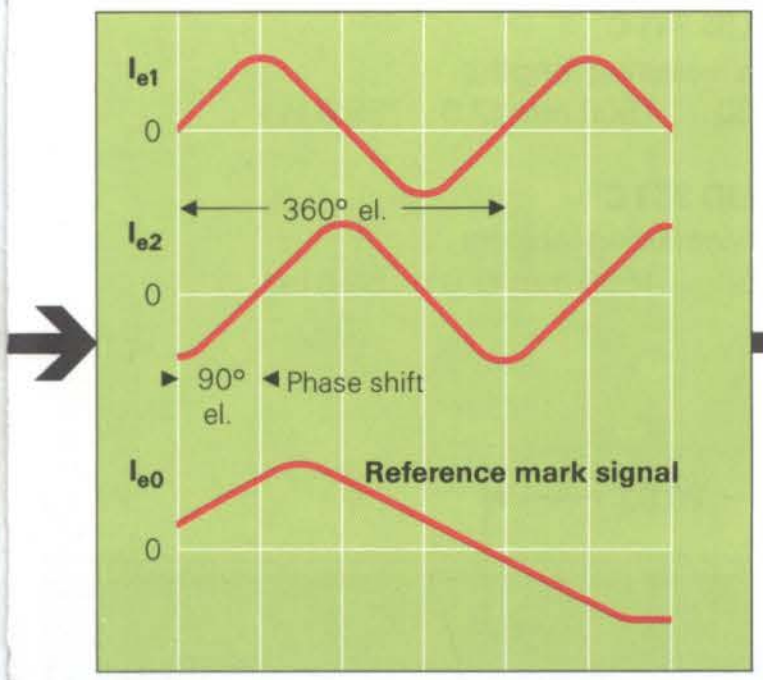
Signal Processing of Incremental Encoders

HEIDENHAIN NC-linear encoders contain no electronics other than the solar cells, and in some instances a semiconductor light source. The measuring signals are processed by an **interpolation and digitizing circuitry**, either contained in a separate box (**EXE**) or in the numerical control (e.g. HEIDENHAIN-**TNC**) or counter (e.g. HEIDENHAIN-**VRZ**).

The periodic signals of the solar cells may be interpolated ×5, ×10 ×25 or x50 e.g. by resistor networks which produce additional phase-shifted signals via vectorial addition. All signals are subsequently transformed into squarewaves by Schmitt-triggers and logically gated such that two square wave pulse trains U_{a1} and U_{a2} – phase-shifted by 90° el. – and a reference pulse U_{a0} are available as an output. The 90° phase shift of the pulse trains U_{a1} and U_{a2} is used to determine direction of movement. Since four edges within one signal cycle are provided for computation of the measured value, the **measuring step** depends on the interpolation factor (×5, ×10, ×25 or ×50) as follows:
The measuring step of a linear encoder is 1/20, 1/40, 1/100 or 1/200 of the grating period.

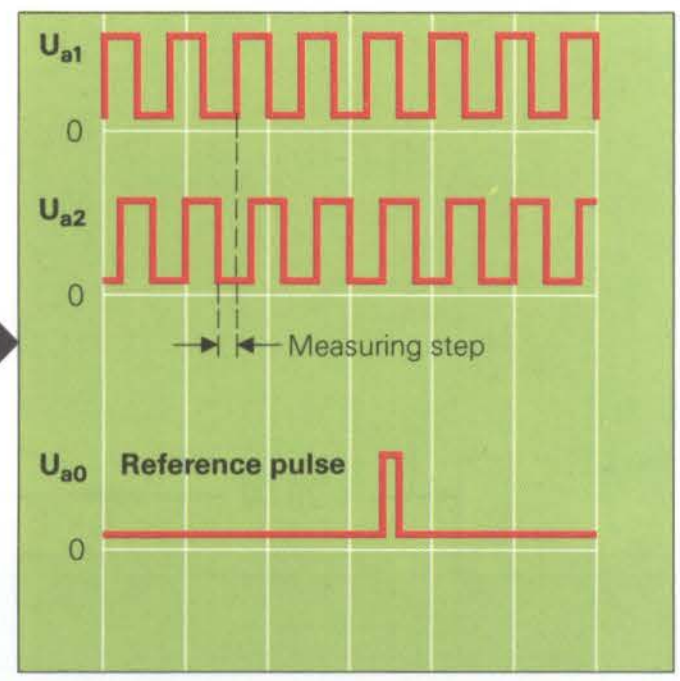
If all four signal edges of both pulse trains are utilized to produce the measured value (4× evaluation), then the counting step corresponds to the measuring step. If only 1 pulse train is utilized (2× evaluation), the counting step corresponds to double the measuring step, or four times of the measuring step when only 1 edge per cycle is evaluated.

For all outputs of the interpolation and digitizing electronics the **inverted signals** are also available for **noise suppression** measures. Additionally a **fault detection signal** (EXE units) indicates malfunctions, e. g. breaks in the lamp filament or wiring.



Scanning signals of encoder

EXE interpolation and digitizing circuitry



Square wave pulse trains after 5fold interpolation and digitizing

Reference mark

The **reference mark** serves as a datum for the machine slides. Before machining begins, a reference point must first be established on the workpiece relative to the machine's fixed reference point. With incremental encoders the **setting of a datum** is quite easy; a certain value is allocated to the reference pulse as an absolute value, e.g. zero.
However, after numerical control switch-off or power failure, the correlation between workpiece-related actual position values and machine slide positions is lost. This correlation can be easily reproduced by traversing the reference mark, thereby generating a reference signal that can be evaluated within the control electronics.

Distance-coded reference marks
When using linear encoders with distance-coded reference marks, the absolute position value can be reproduced by crossing two consecutive reference marks, i.e. with a traverse of maximally 20 mm (0.8 in.).
The scale comprises a grating and an adjacent track of reference marks. The distances between the reference marks vary by a defined rule. By determining the distance between two consecutive reference marks, their absolute position can be established.
The following linear encoders are available with distance-coded reference marks:

LS 101 C
Measuring lengths
140 . . . 1240 mm (5.5 . . . 48.8 in.)

LS 107 C
Measuring lengths
240 . . . 3040 mm (9.5 . . . 120.0 in.)

LS 403 C
Measuring lengths
70 . . . 2040 mm (2.7 . . . 80.3 in.)

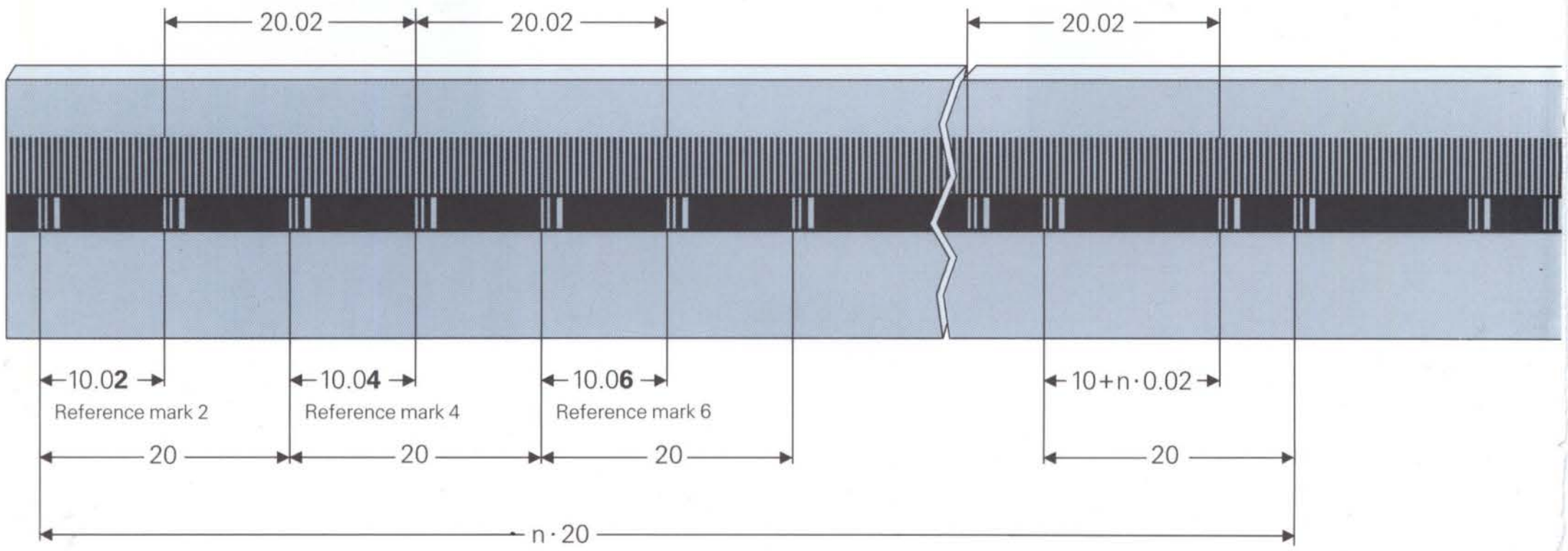
LS 404 C
Measuring lengths
70 . . . 620 mm (2.7 . . . 24.4 in.)

LS 704 C
Measuring lengths
170 . . . 3040 mm (6.7 . . . 120.0 in.)

ULS 300 C
Measuring lengths
170 . . . 520 mm (6.7 . . . 20.5 in.)

LID 311 C
Measuring lengths
50 . . . 1500 mm (2.0 . . . 59.0 in.)

LID 351 C
Measuring lengths
50 . . . 1500 mm (2.0 . . . 59.0 in.)



Dimensions in mm

DIADUR glass scale with distance-coded reference marks

Measuring accuracy

Specification of the measuring accuracy is made in **accuracy grades.** The accuracy grade ± a µm or ± b in., respectively is defined as follows:

The extreme values of the deviation F with reference to their mean value lie within – a µm ≦ F ≦ + a µm for any random max. 1 m section of the measuring length (– b in. ≦ E ≦ + b in. for 40 in. sections).

With **sealed linear encoders,** this value applies to the complete scale unit; this is referred to as the system accuracy.
With **exposed linear encoders** the definition of the accuracy grade refers to the scale (scale accuracy).

A **calibration chart** is supplied with every HEIDENHAIN NC-linear encoder.

Machine error compensation
HEIDENHAIN linear encoders LS 107, LB 326 and LIDA 225 offer a possibility for systematic compensation of geometrical machine errors.
By tensioning the tape scale (LIDA 225, LB 326), machine errors can be compensated linearly over the total measuring length.

An adjustable chain of correction guiders within the encoder with adjustment points either at 100 mm (4 in.) intervals for LS 107, or at 200 mm (7.9 in.) intervals for LB 326 is provided for compensation of local machine errors.

LS 403 * S.Nr. 1754288F * Id.Nr. 22652018

Werksbescheinigung

Das Längenmeßsystem wurde unter den strengen HEIDENHAIN-Qualitätsnormen hergestellt und geprüft.
Die Meßabweichung liegt innerhalb der Genauigkeitsklasse
± 5 µm
(Bezugstemperatur 20° C).

Certificate of inspection

This linear transducer has been manufactured and inspected in accordance with the stringent quality standards of HEIDENHAIN.
The measured deviation lies within the accuracy grade
± 5 µm
(reference temperature 20° C/68° F).

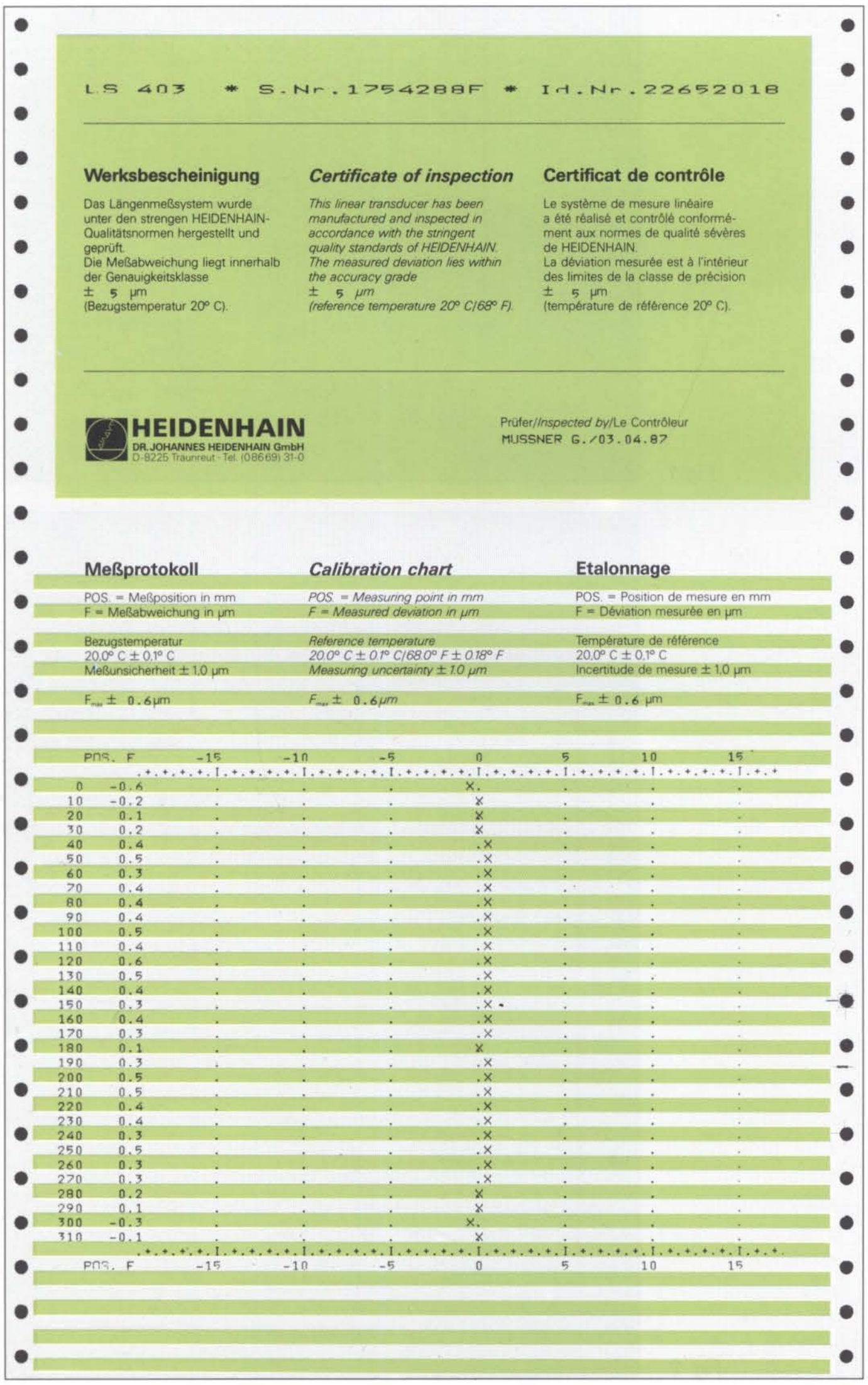
Certificat de contrôle

Le système de mesure linéaire a été réalisé et contrôlé conformément aux normes de qualité sévères de HEIDENHAIN.
La déviation mesurée est à l'intérieur des limites de la classe de précision
± 5 µm
(température de référence 20° C).

HEIDENHAIN
DR. JOHANNES HEIDENHAIN GmbH
D-8225 Traunreut · Tel. (08669) 31-0

Prüfer/*Inspected by*/Le Contrôleur
MUSSNER G./03.04.87

Meßprotokoll	***Calibration chart***	**Etalonnage**
POS. = Meßposition in mm	*POS. = Measuring point in mm*	POS. = Position de mesure en mm
F = Meßabweichung in µm	*F = Measured deviation in µm*	F = Déviation mesurée en µm
Bezugstemperatur	*Reference temperature*	Température de référence
20,0° C ± 0,1° C	*20.0° C ± 0.1° C/68.0° F ± 0.18° F*	20,0° C ± 0,1° C
Meßunsicherheit ± 1,0 µm	*Measuring uncertainty ± 1.0 µm*	Incertitude de mesure ± 1,0 µm
F_{max} ± 0.6µm	F_{max} ± 0.6µm	F_{max} ± 0.6 µm



Traversing Speed

The **max. traversing speed** of linear encoders is dependent on:
- the **mechanically** permissible traversing speed
- the max. input frequency of the **interpolation and digitizing electronics**
- the min. permissible edge separation of the squarewave output signals U_{a1} and U_{a2} of the digitizing electronics for further processing within the **control electronics.**

The **mechanically permissible traversing speed** for each linear encoder is indicated in this catalogue under mechanical data.
The max. traversing speed depending on the max. input frequency of the **interpolation and digitizing electronics** is derived as follows:

$\mathbf{v}_{max}$ (mm/s) $= \mathbf{p} \cdot \mathbf{f}_{max}$, or

$\mathbf{v}_{max}$ (m/min) $= \mathbf{p} \cdot \mathbf{f}_{max} \cdot 6 \cdot 10^{-2}$, or

$\mathbf{v}_{max}$ (ft/min) $= \mathbf{p} \cdot \mathbf{f}_{max} \cdot 19.68 \cdot 10^{-2}$

$\mathbf{v}_{max}$: maximum traversing speed
p: grating period of scale in µm, or signal cycle of linear encoders with phase grating
$\mathbf{f}_{max}$: input frequency of interpolation electronics in kHz

In Fig. 1 this relationship is illustrated for the various max. permissible input frequencies of the HEIDENHAIN interpolation and digitizing electronics EXE. The max. input frequency for each EXE version is given in the EXE catalogue, or in the table of types in the supplement.

In general, the **control electronics** only allow a certain minimum edge separation for the squarewave output signals of the digitizing electronics.
The relationship between input frequency "**f**" of the HEIDENHAIN-EXE and the edge separation "**a**"of output signals U_{a1} and U_{a2}, with a given interpolating factor of the interpolation electronics is illustrated in Fig. 2. The input frequency can be derived as follows:

$$\mathbf{f}\ (\text{kHz}) = \frac{\mathbf{v}\ (\text{m/min})}{\mathbf{p}\ (\mu\text{m})} \cdot \frac{1}{6} \cdot 10^2$$

$$\mathbf{f}\ (\text{kHz}) = \frac{\mathbf{v}\ (\text{ft/min})}{\mathbf{p}\ (\mu\text{m})} \cdot \frac{1}{19.68} \cdot 10^2$$

v: traversing speed

p: grating period of scale or signal cycle of linear encoders with phase grating

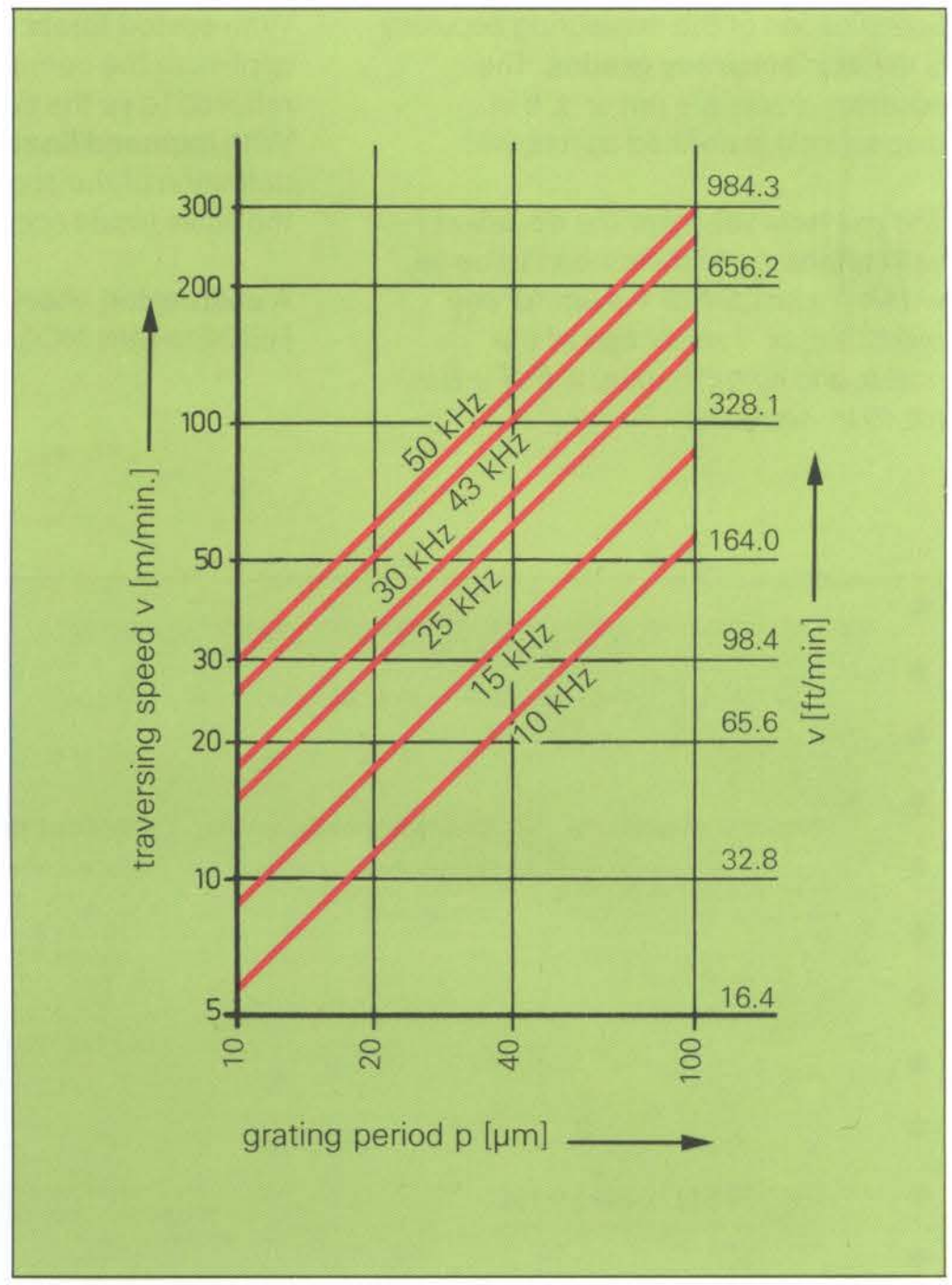


Fig. 1

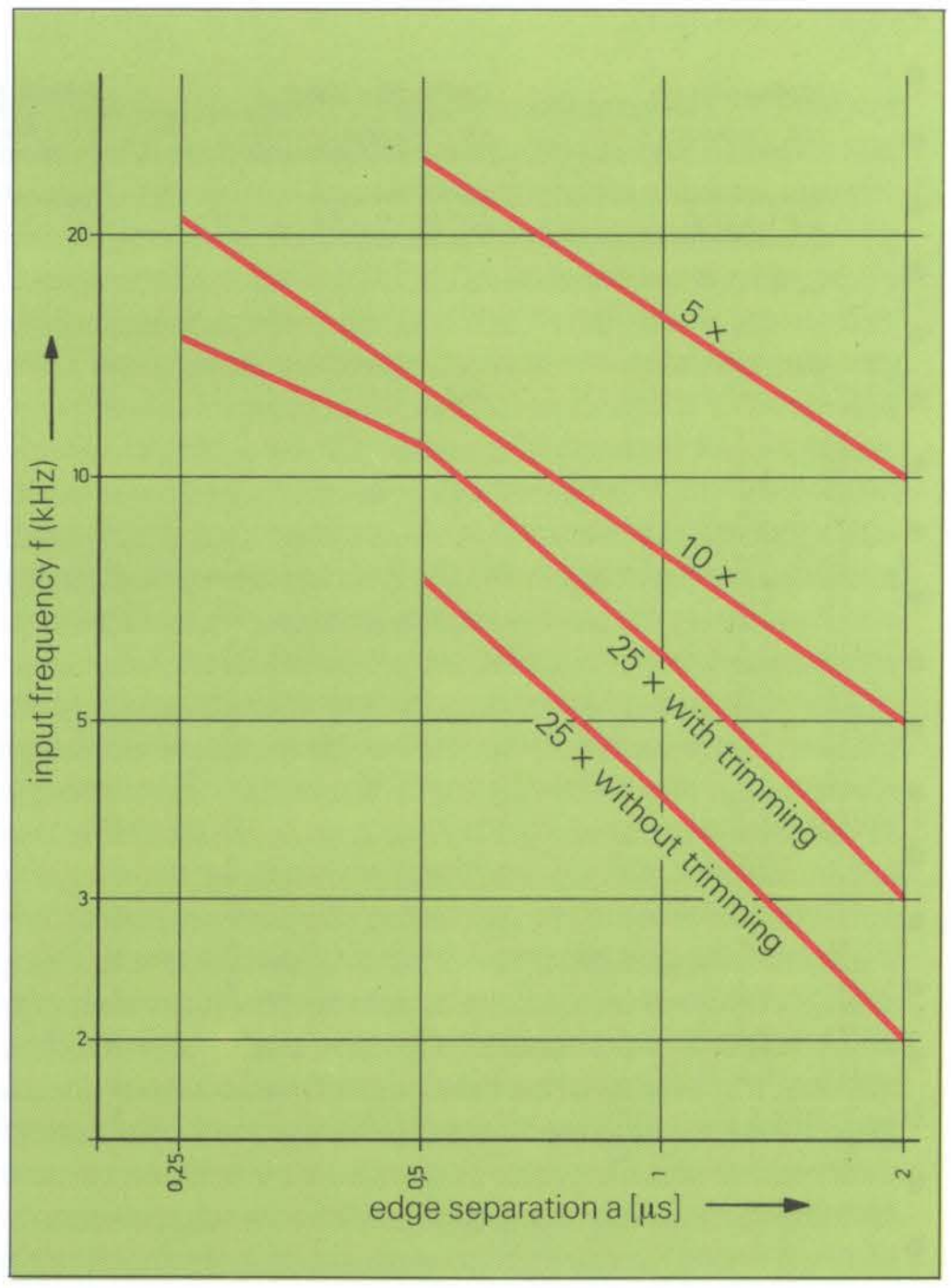


Fig. 2

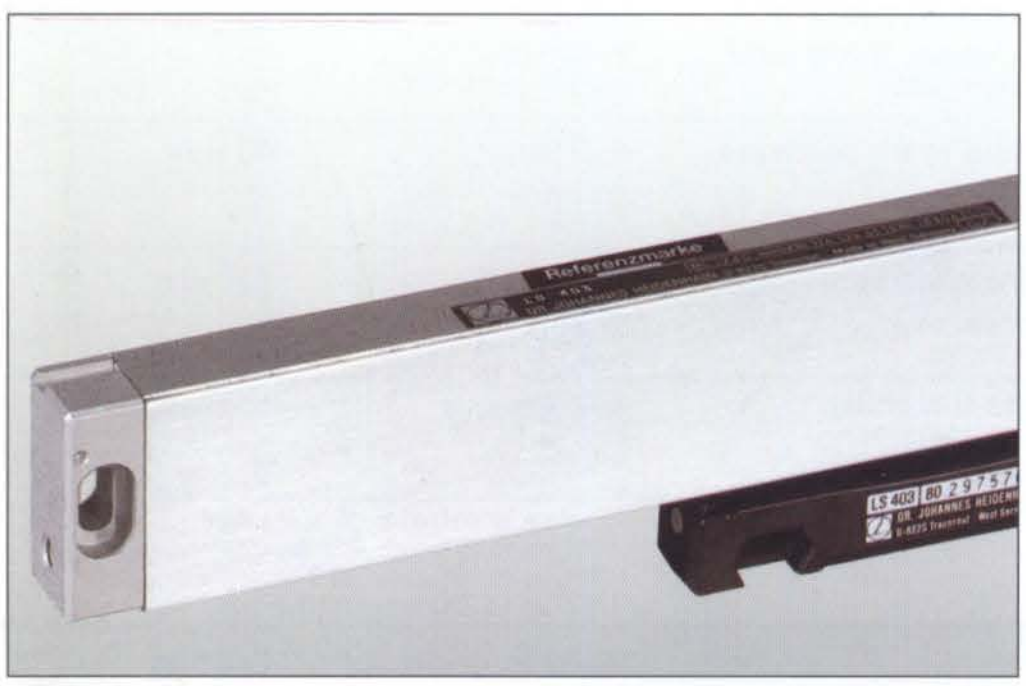
Mechanical Design

Sealed linear encoders
Scale and scanning unit of sealed linear encoders are protected against chips, swarf, dust and splashwater by an aluminum housing with flexible sealing lips.
The scanning unit is guided within the scale unit with low friction. It is connected to the external mounting block via a coupling which compensates for lateral offsets without measuring errors.
Distance variations between scale and mounting block of ± 0.2 mm (± 0.008 in.) with LS 101/LS 107 and ± 0.3 mm (± 0.012 in.) with LS 403/LS 404, LS 704, LB 326 are compensated.
The mounting block is normally fixed to the stationary member of the machine.
The electrical wiring extends through the connecting web and then from the mounting block to the subsequent electronics via a shielded cable.
All sealed linear encoders are available with metal-armored cable (standard feature with LS 101, LS 107, LB 326).
The sealed linear encoders LS 403 and LS 404 are employable for **limited installation space;** their maximum measuring length is limited to 2040 mm or 80.3 in. (LS 403), and 620 mm or 24.4 in. (LS 404).

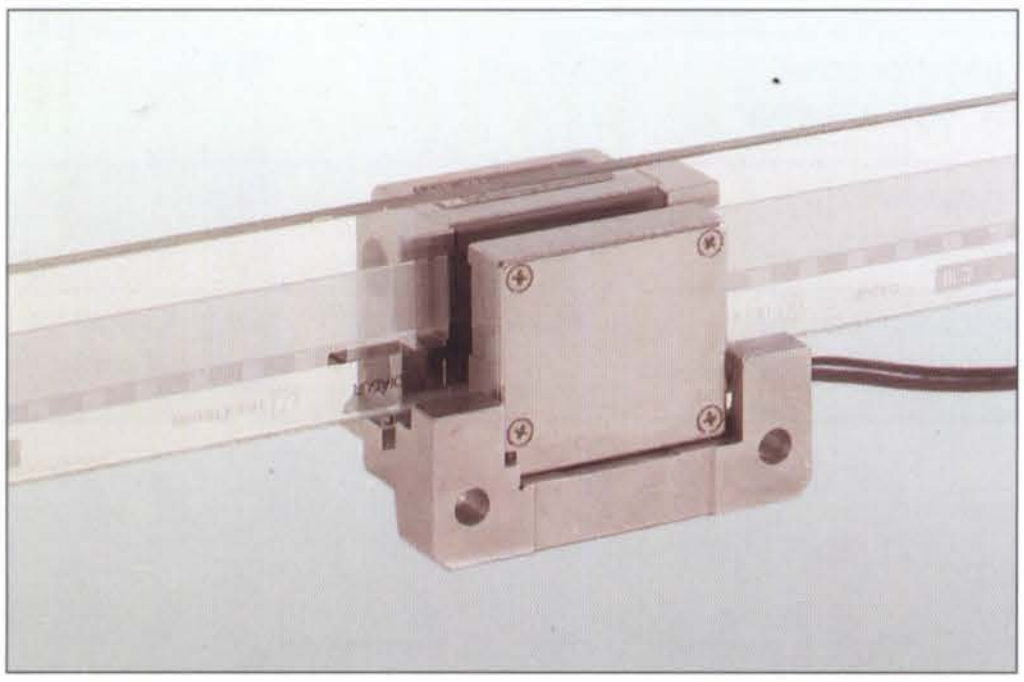
When mounted in the recommended attitude, **dust and splashwater protection** corresponds to IP 53 of standards IEC 529 or IEC 144.
By generating a small positive air **pressure** within the encoder, additional protection against contamination, e.g. coolant/lubricant can be achieved. For **air purging**, all LS and LB 326 linear encoders are provided with a standard inlet in one or both scale end pieces. Compressed air can also be connected at the mounting block of the scanning unit. The compressed air must be cleaned by a microfilter. The recommended flow rate is 3...5 l/min per encoder. The HEIDENHAIN product program includes units for preparation of the compressed air as well as T-joints, tubing and connection pieces with incorporated throttles.

Exposed linear encoders
With exposed linear encoders, the light source and scanning unit are sealed within the scanning head in accordance with IP 50 for LID and IP 53 for LIDA versions. It is recommended that the scale be protected against contamination.
In order to guarantee satisfactory operation, the specified mounting clearances and tolerances (see dimensions) between scanning head and scale, i.e. from ± 0.015 mm (± 0.0006 in.) with LID 351 to ± 0.2 mm (± 0.008 in.) with LIDA 201, must be observed and permanently ensured by the machine guideway.

Cabling
Remarks on connecting and leading the cable are contained in the mounting instructions.
Providing that the wiring regulations have been observed, all HEIDENHAIN encoders are insensitive to electrical or magnetic interference caused by e.g. electrical discharge machines or electrical motors which are located nearby.



Sealed
linear encoder
LS 403



Exposed
linear encoder
LID 351

NC-Linear Encoders

Sealed linear encoders

Recommended measuring steps	Linear encoder		System accuracy grades	Grating period
1 µm/0.5 µm/ 0.2 µm/0.1 µm	**LS 101,** **LS 101 C**	Sealed linear encoder with highest resolution	± 5 µm ± 3 µm ± 2 µm	10 µm
1 µm/0.5 µm	**LS 107,** **LS 107 C**	With sectional machine error compensation	± 5 µm ± 3 µm ± 2 µm	20 µm
1 µm/0.5 µm	**LS 403, LS 403 C** **LS 404, LS 404 C**	For limited installation place	± 5 µm ± 3 µm*	20 µm
1 µm/0.5 µm	**LS 704,** **LS 704 C**	Standard linear encoders, robust design	± 5 µm ± 3 µm*	20 µm
1 µm	**LB 326**	For large traverses, with machine error compensation	± 5 µm	100 µm
1 µm/0.5 µm/ 0.2 µm	**ULS 300,** **ULS 300 C**	Fully sealed universal linear encoders	± 3 µm ± 2 µm**	20 µm

* up to 1240 mm (48.8 in.) only

** 170 mm (6.7 in.) and 270 mm (10.6 in.) only

"Exposed" linear encoders

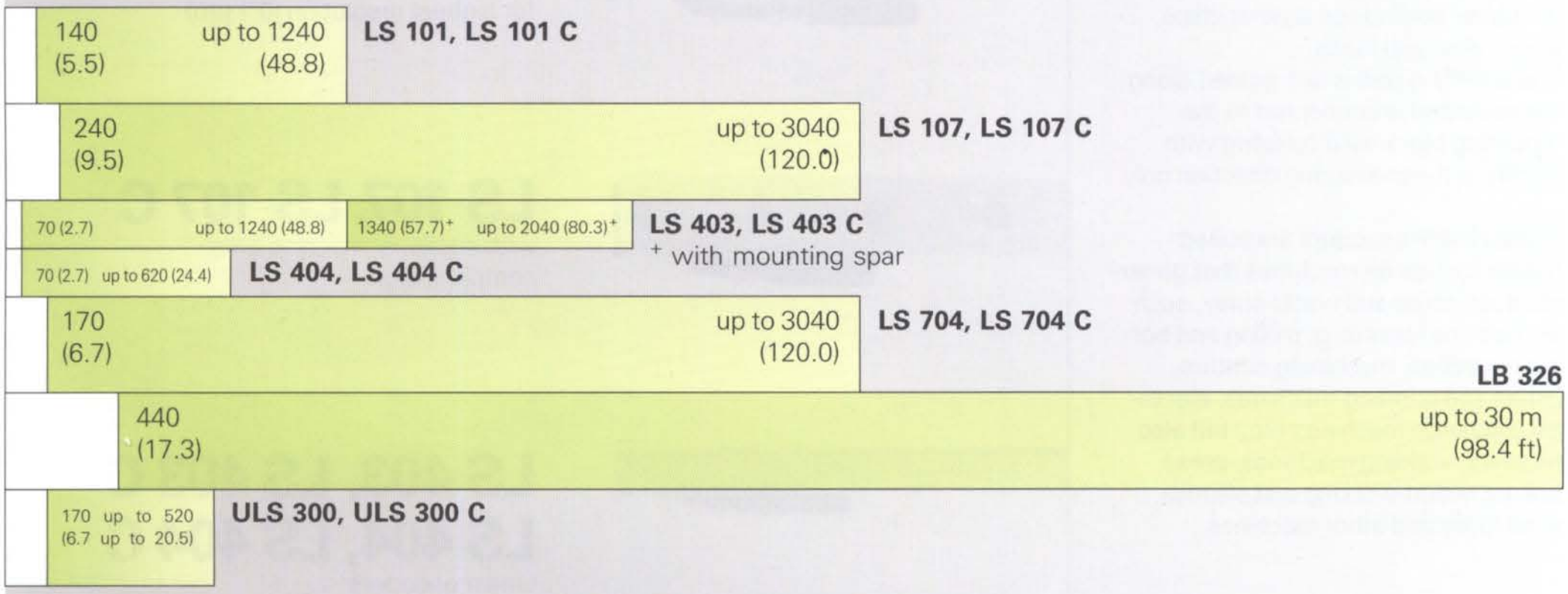
Recommended measuring steps	Linear encoder		Scale accuracy grades	Grating period
1 µm/0.2 µm/ 0.1 µm/0.02 µm	**LIP 101**	Very high resolution, with very high accuracy	± 2 µm/± 1 µm ± 0.5 µm* ± 0.2 µm**	8 µm (signal period 4 µm)
1 µm/0.5 µm/ 0.2 µm/0.1 µm 0.05 µm	**LID 311,** **LID 311 C**	For measuring machines, high resolution with high accuracy	± 1 µm ± 0.5 µm*** ± 0.2 µm****	10 µm
1 µm/0.5 µm/ 0.2 µm/0.1 µm/ 0.05 µm	**LID 351,** **LID 351 C**	High resolution with high accuracy, integrated adjustment aid	± 1 µm ± 0.5 µm*** ± 0.2 µm****	10 µm
1 µm	**LIDA 190**	Reference mark positions as required	± 5 µm ± 3 µm	40 µm
1 µm	**LIDA 201**	Large installation tolerances	± 5 µm ± 3 µm	100 µm
1 µm	**LIDA 225**	For large traverses, with linear machine error compensation	± 5 µm	100 µm

* up to 520 mm (20.5 in.) only
** up to 220 mm (8.6 in.) only
*** up to 500 mm (19.7 in.) only
**** up to 200 mm (7.9 in.) only

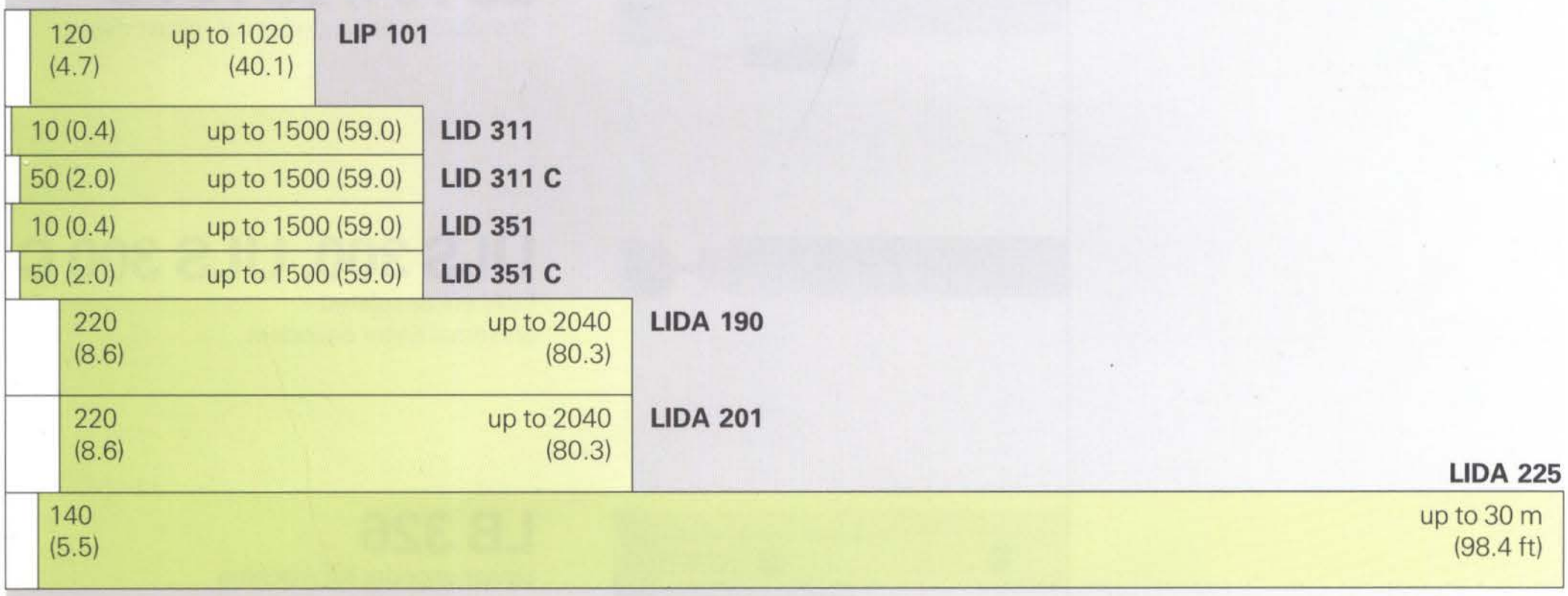
Special linear encoders

Recommended measuring steps	Linear encoder		System accuracy grade	Grating period
1 µm/0.5 µm/ 0.2 µm/0.1 µm 0.05 µm	**MT 60K**	Length gage for small traverses, high accuracy	± 0.5 µm	10 µm
1 µm/0.5 µm/ 0.2 µm/0.1 µm 0.05 µm	**MT 101K**	Length gage for small traverses	± 1 µm	10 µm
1 µm/0.2 µm/ 0.1 µm/0.02 µm	**VM 101**	Comparator system for calibrating small machine tools	± 1 µm	8 µm (signal period 4 µm)

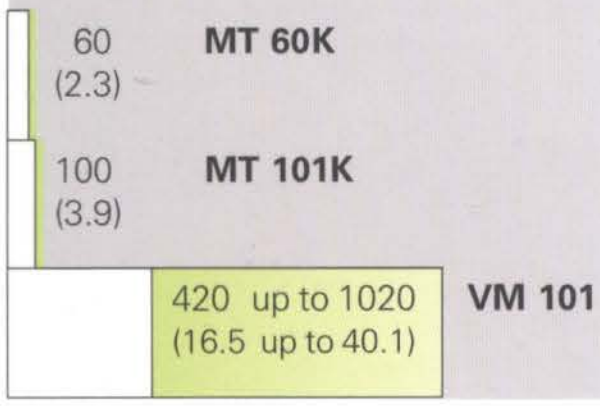
Measuring lengths
mm (inch)



Measuring lengths
mm (inch)



Measuring lengths
mm (inch)



Sealed Linear Encoders

In sealed linear encoders the scale and the scanning unit are protected by an aluminum housing and flexible synthetic rubber sealing lips against chips, swarf, dust and fluids.
The scanning unit is self-guided along the scale and is connected to the mounting block via a coupling with rigidity in the measuring direction only.

Sealed linear encoders are suited mainly for use on machines that generate dust, chips and water spray, such as machine tools (e.g. milling and boring machines, machining centers, lathes and grinding machines, electrical discharge machines etc.) but also on saws, welding machines, press brakes, wood-working and plastics machinery and other machines.

LS 101, LS 101 C

. Sealed linear encoders
for highest resolution (0.1 µm)

LS 107, LS 107 C

. with sectional machine error
compensation

LS 403, LS 403 C
LS 404, LS 404 C

. Linear encoders
with small cross section
for limited installation space

LS 704, LS 704 C

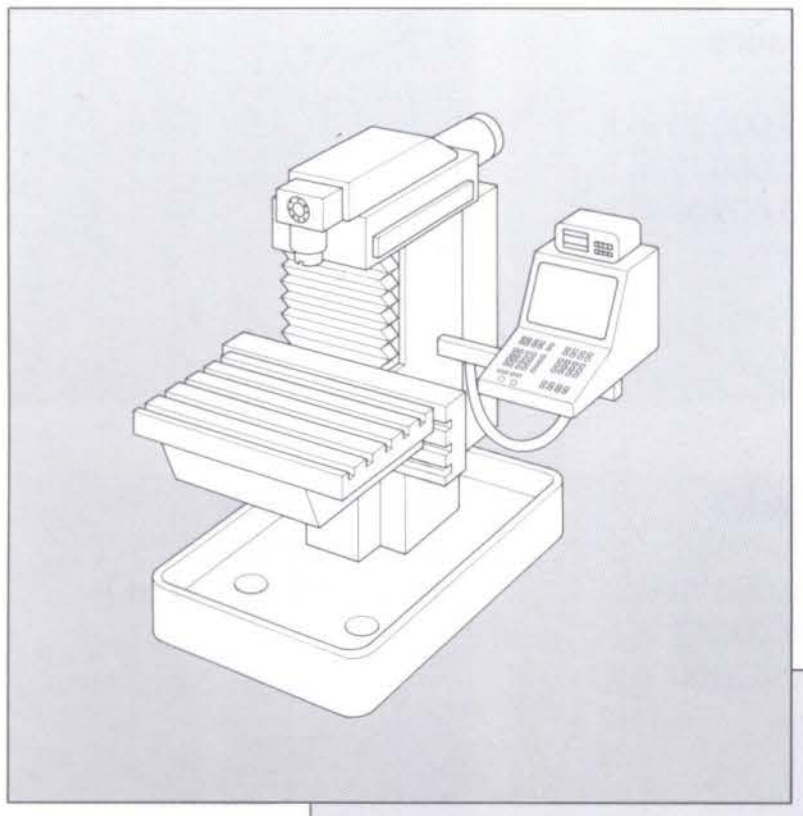
. Standard linear encoders of robust design

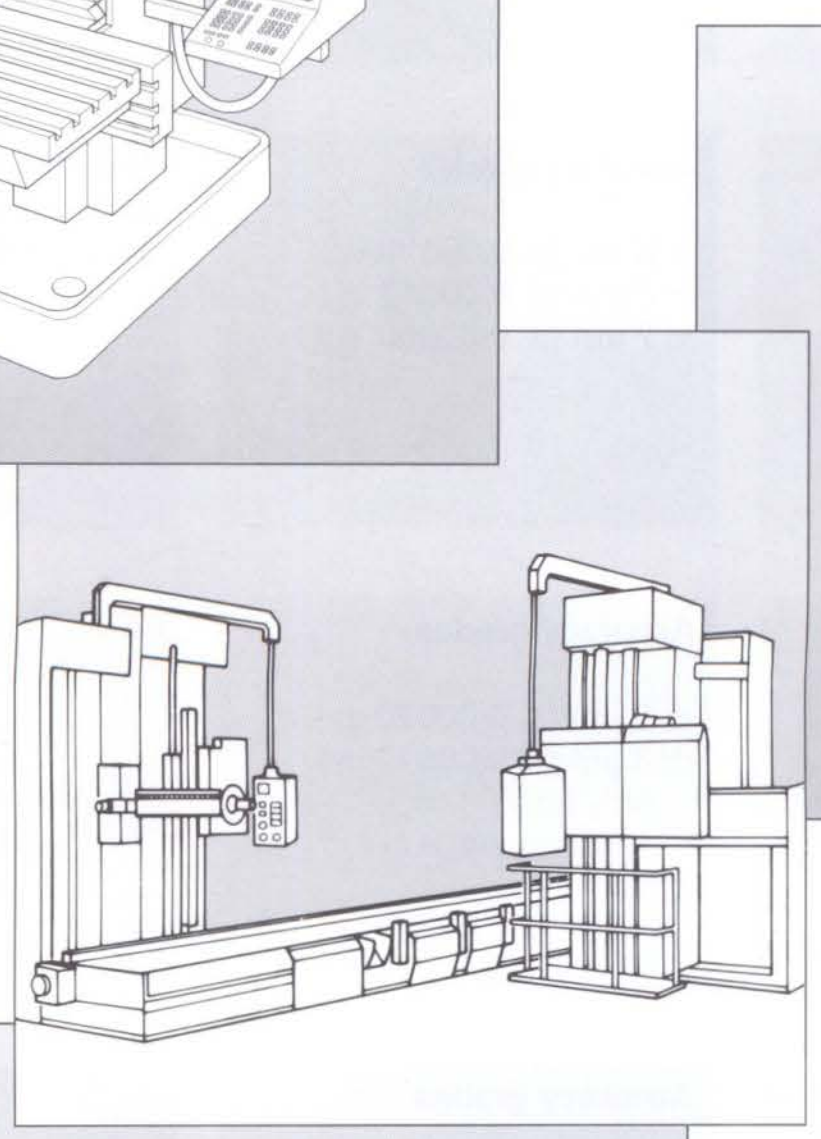
ULS 300, ULS 300 C

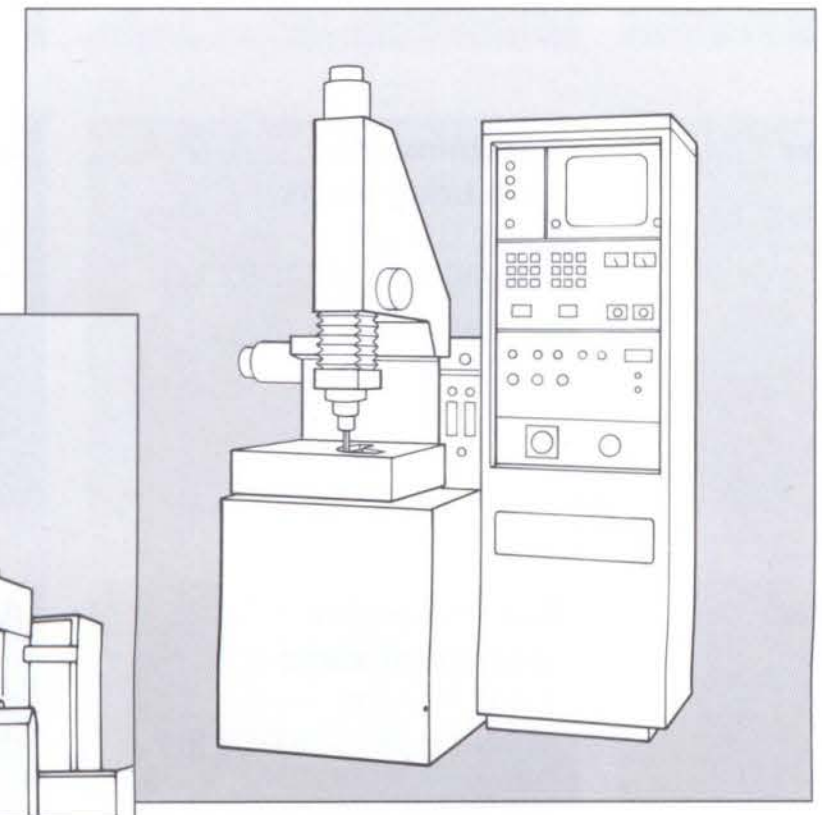
. Fully encapsulated
universal linear encoders

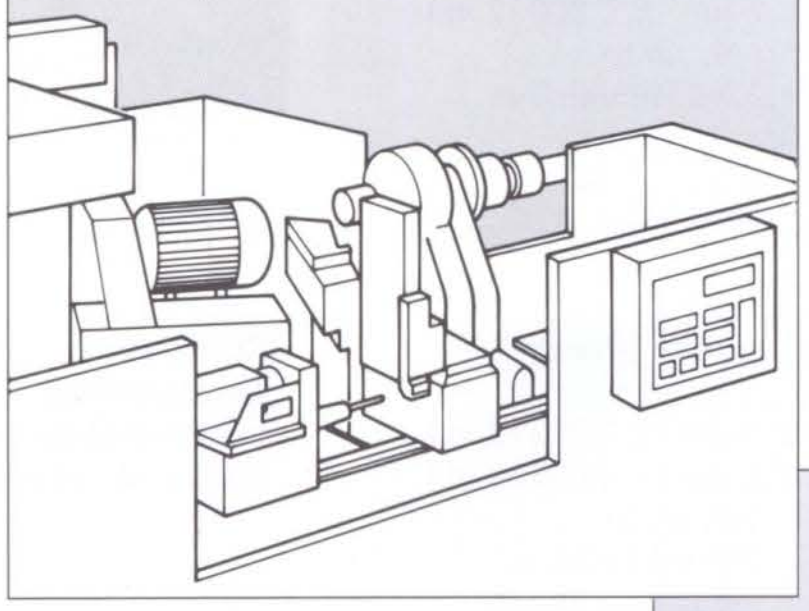
LB 326

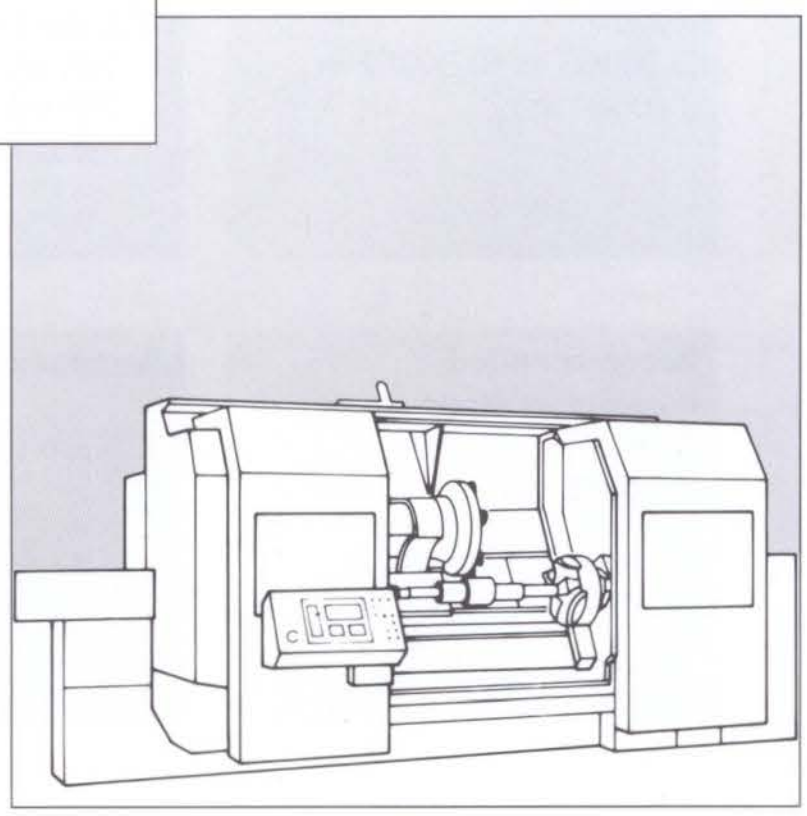
. Linear encoder for machine
tools with large lengths of traverse
. with machine error compensation











Sealed Linear Encoders

Measuring lengths
up to 1240 mm
(48.8 in.)

Recommended measuring steps
1 µm, 0.5 µm,
0.2 µm, ***0.1 µm***
(0.00005 in., 0.00002 in.,
0.00001 in., ***0.000005 in.***)

Accuracy grades

± 5 µm (± 0.00020 in.)
± 3 µm (± 0.00012 in.)
± 2 µm (± 0.00008 in.)

Measuring lengths
up to 3040 mm
(120.0 in.)

Recommended measuring steps
1 µm, 0.5 µm
(0.00005 in., 0.00002 in.)

Accuracy grades

± 5 µm (± 0.00020 in.)
± 3 µm (± 0.00012 in.)
± 2 µm (± 0.00008 in.)

Machine error compensation every 100 mm (4 in.)

Measuring lengths
up to 2040 mm
(80.8 in.)

Recommended measuring steps
1 µm, 0.5 µm
(0.00005 in., 0.00002 in.)

Accuracy grades

± 5 µm (± 0.00020 in.)
± 3 µm (± 0.00012 in.)
only up to
1240 mm/48.8 in.

Measuring lengths
up to 3040 mm
(120.0 in.)

Recommended measuring steps
1 µm, 0.5 µm
(0.00005 in., 0.00002 in.)

Accuracy grades

± 5 µm (± 0.00020 in.)
± 3 µm (± 0.00012 in.)
only up to
1240 mm/48.8 in.

Measuring lengths
up to 520 mm
(20.5 in.)

Recommended measuring steps
1 µm, 0.5 µm,
0.2 µm
(0.00005 in., 0.00002 in.,
0.00001 in.)

Accuracy grades

± 3 µm (± 0.00012 in.)
± 2 µm (± 0.00008 in.)
only up to
270 mm/10.6 in.
measuring length

Completely encapsulated linear encoder with push rod activation

Measuring lengths
up to 30 m
(98.4 ft)

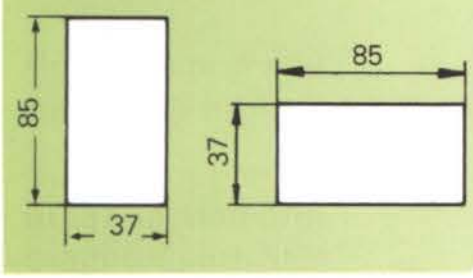
Recommended measuring steps
1 µm
(0.00005 in.)

Accuracy grades

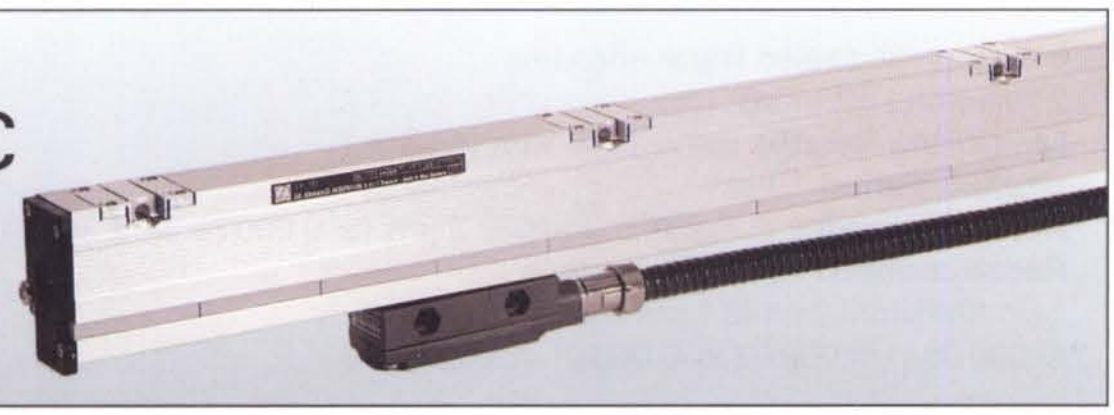
± 5 µm (± 0.00020 in.)

Machine error compensation
. linear over total length
. additionally every 200 mm (7.9 in.)

Cross-section and mounting attitudes



LS 101
LS 101 C



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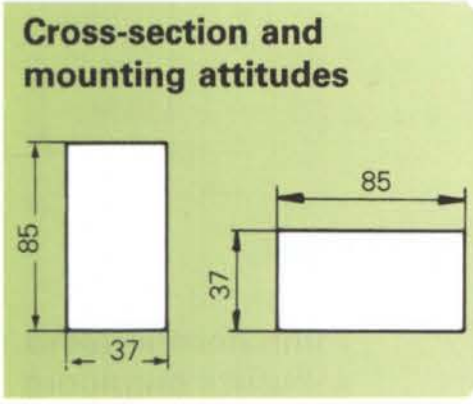
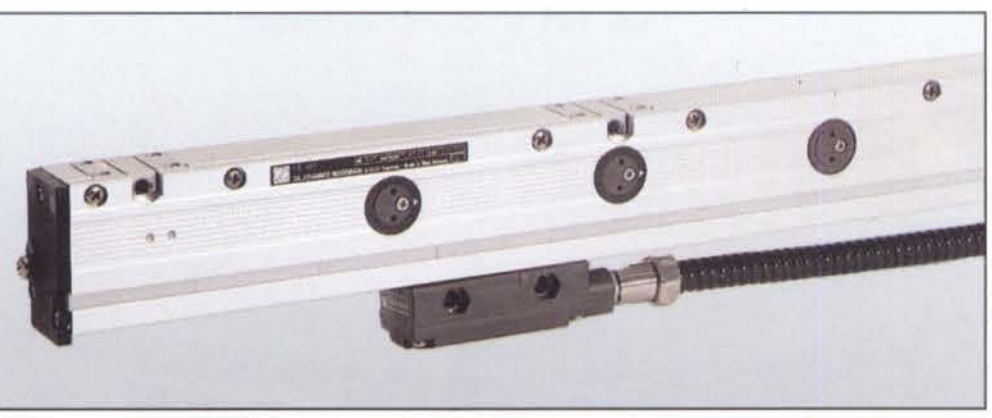
Cross-section and mounting attitudes



LS 107
LS 107 C



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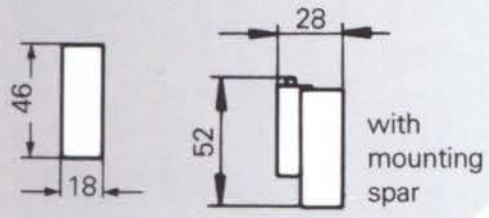
Cross-section and mounting attitudes



LS 403, LS 403 C
LS 404, LS 404 C

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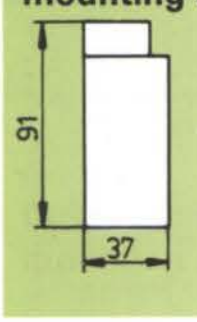
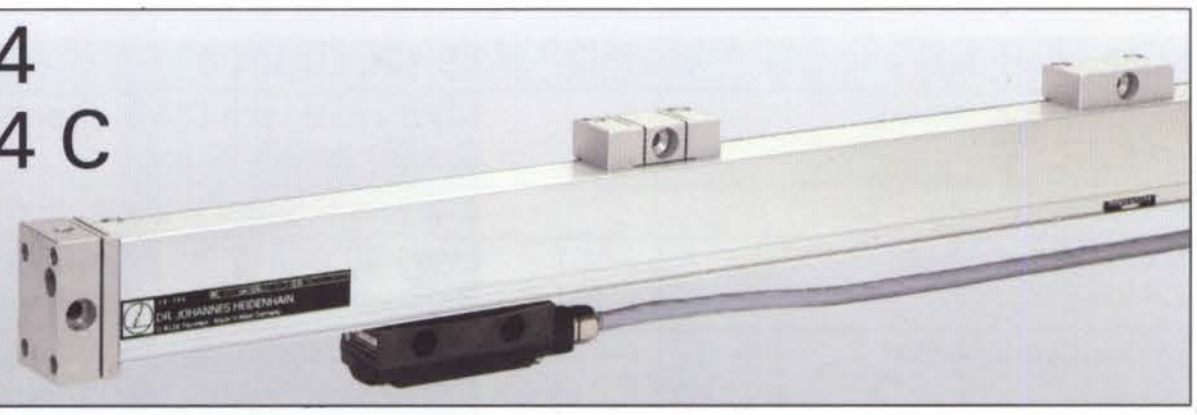
Cross-section and mounting attitude



LS 704
LS 704 C



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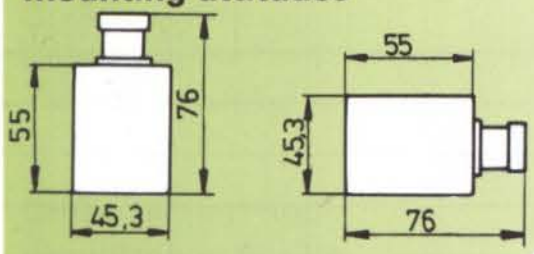
Cross-section and mounting attitudes



ULS 300
ULS 300 C

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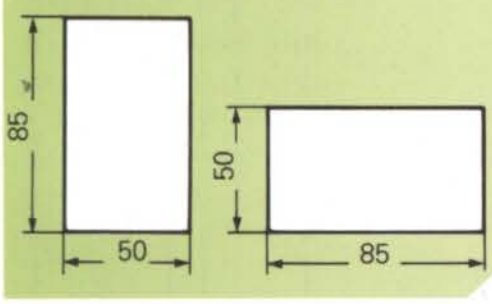
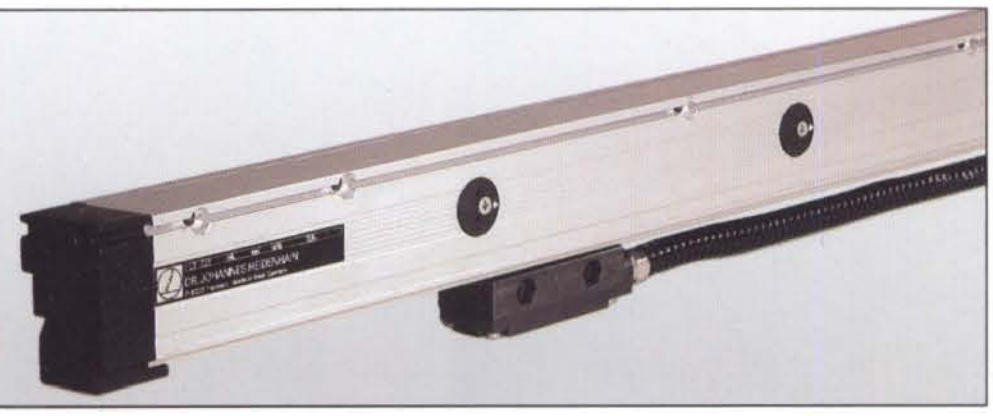
Cross-section and mounting attitudes



LB 326



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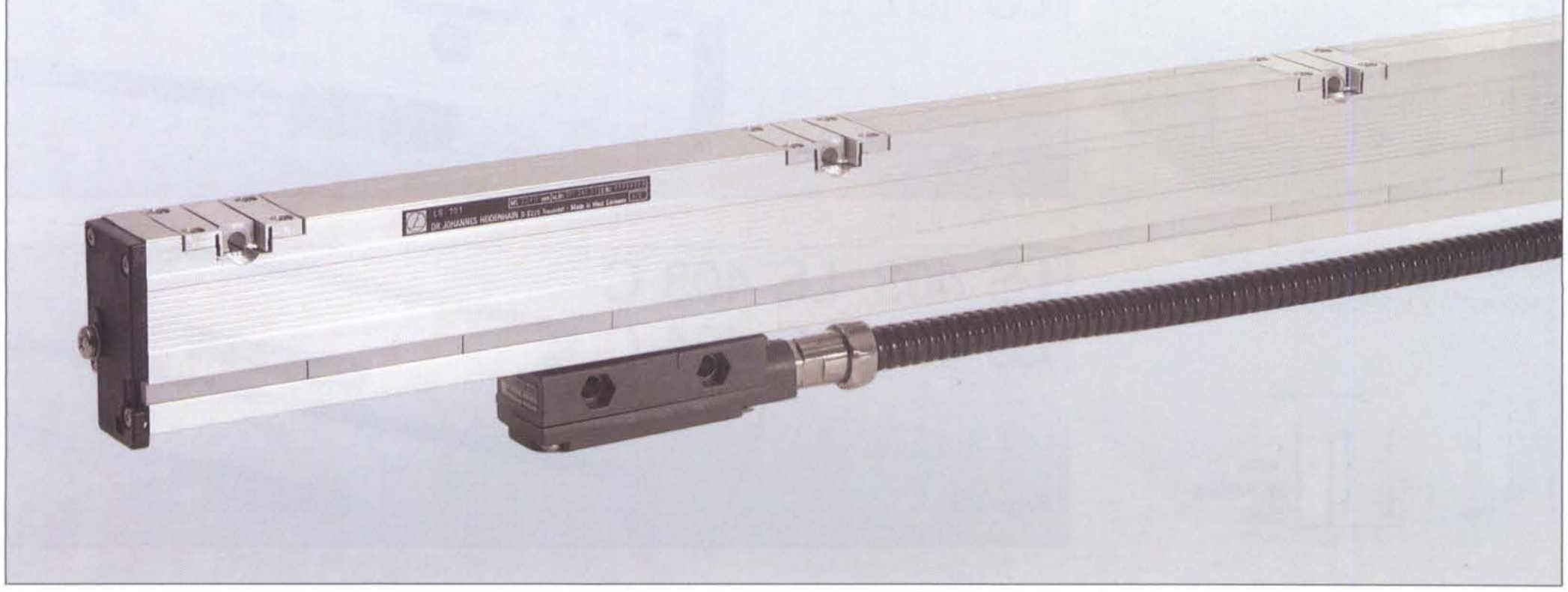
Linear Encoders LS 101, LS 101 C – especially for high resolution

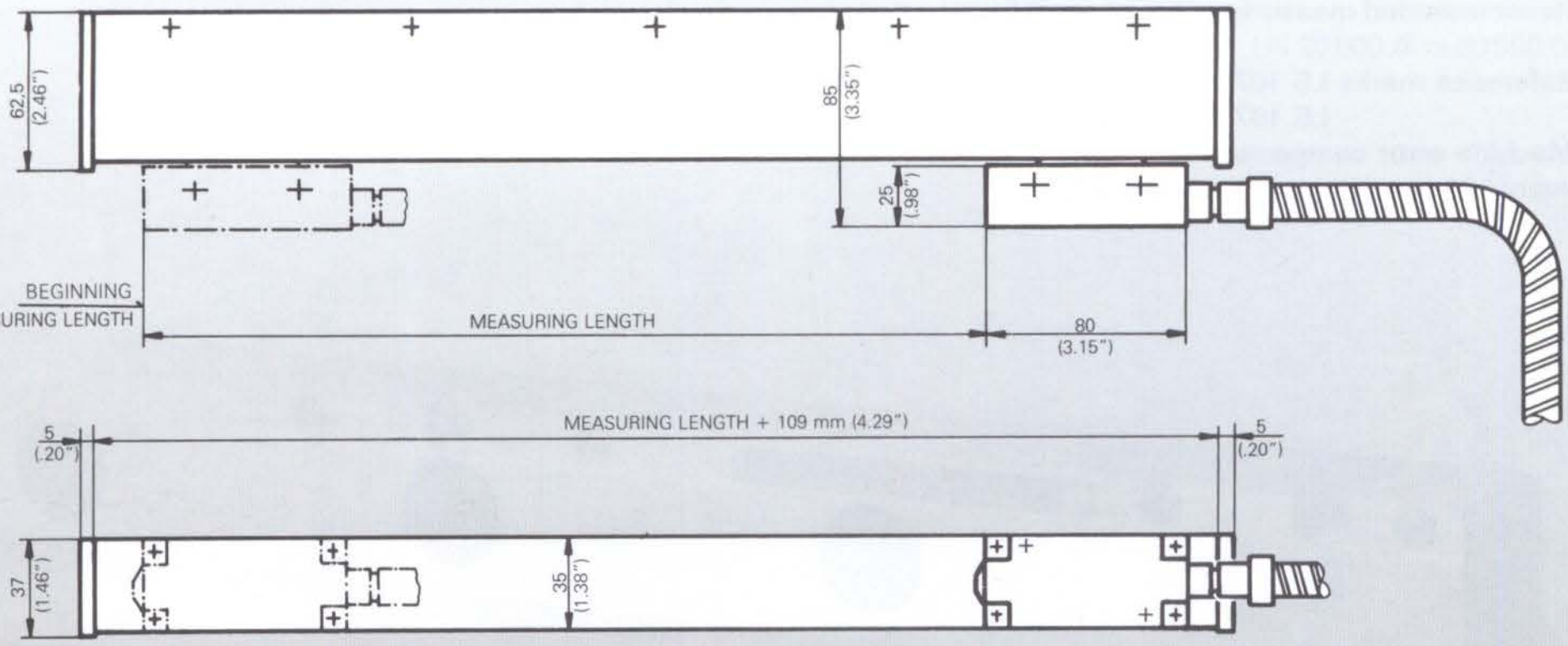
Incremental, sealed linear encoders
2 mounting attitudes
Measuring lengths up to 1240 mm (48.8 in.)
Grating period 10 µm
Accuracy grades ± 5 µm/± 3 µm/± 2 µm (± 0.00020 in./± 0.00012 in./± 0.00008 in.)
Recommended measuring steps
1 µm/0.5 µm/0.2 µm/0.1 µm
(0.000 05 in./0.000 02 in./0.000 01 in./0.000 005 in.)

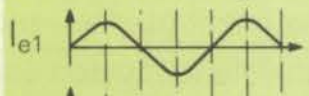
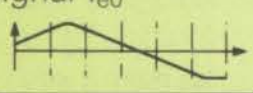
Reference marks LS 101: every 50 mm (2 in.), via selector magnets
LS 101 C: distance-coded



Mechanical data		**LS 101, LS 101 C**
Measuring standard		Glass scale with DIADUR-grating Grating period 10 µm
Accuracy grades		± 5 µm/± 3 µm/± 2 µm (± 0.0002 in./± 0.00012 in./± 0.00008 in.)
Reference marks	LS 101 LS 101 C	every 50 mm (2 in.) possible (activated via selector magnets) distance-coded reference marks
Measuring lengths	mm inch	140/190/240/340/440/540/640/740/840/940/1040/1140/1240 5.5/7.5/9.5/13.4/17.3/21.3/25.2/29.0/33.0/37.0/41.0/44.9/48.8
Max. traversing speed		30 m/min (100 ft/min)
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)		 30 m/s^2 200 m/s^2
Required moving force		≦ 4 N
Operating temperature		0 ... 40°C (32 ... 104°F)
Storage temperature		–20 ... 70°C (–4 ... 158°F)
Weigth		1 kg + 2,6 kg/m measuring length (2.2 lb + 1.74 lb/ft)
Connecting cable		3 m (10 ft), with connector and armored sheathing (standard)

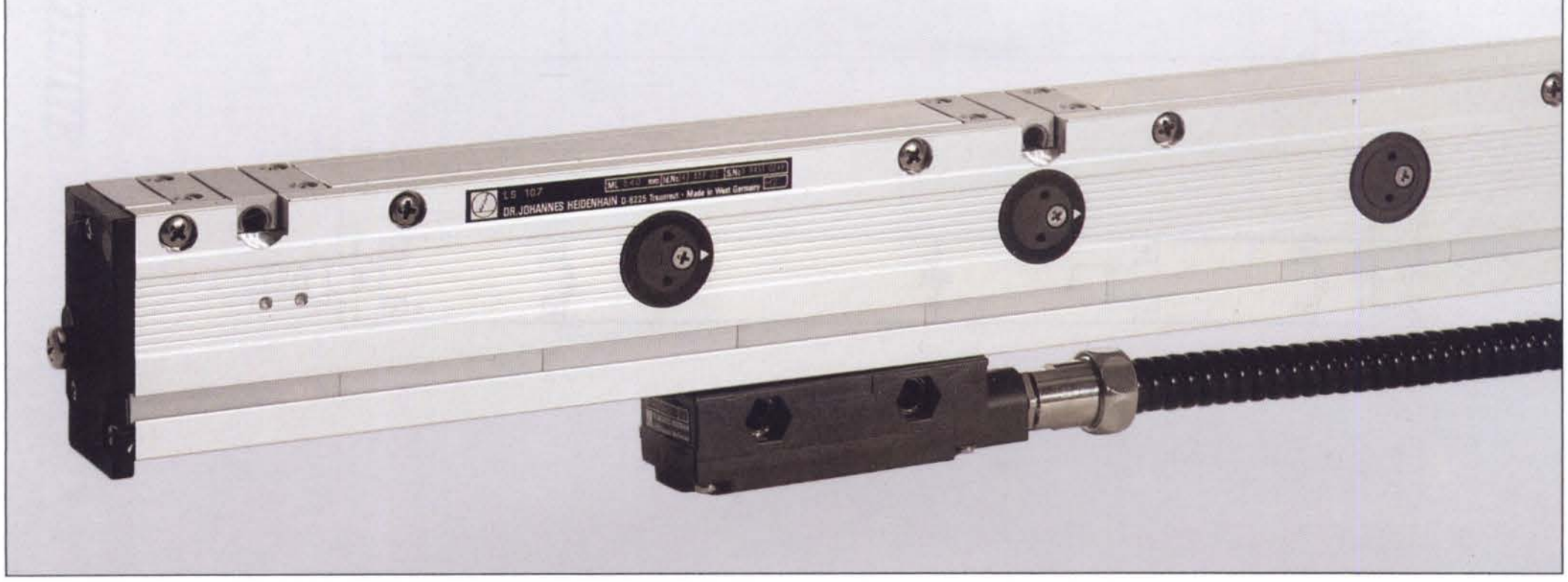
Dimensions in mm (inch)



Electrical data		**LS 101, LS 101 C**
Light source		LED
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2}
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

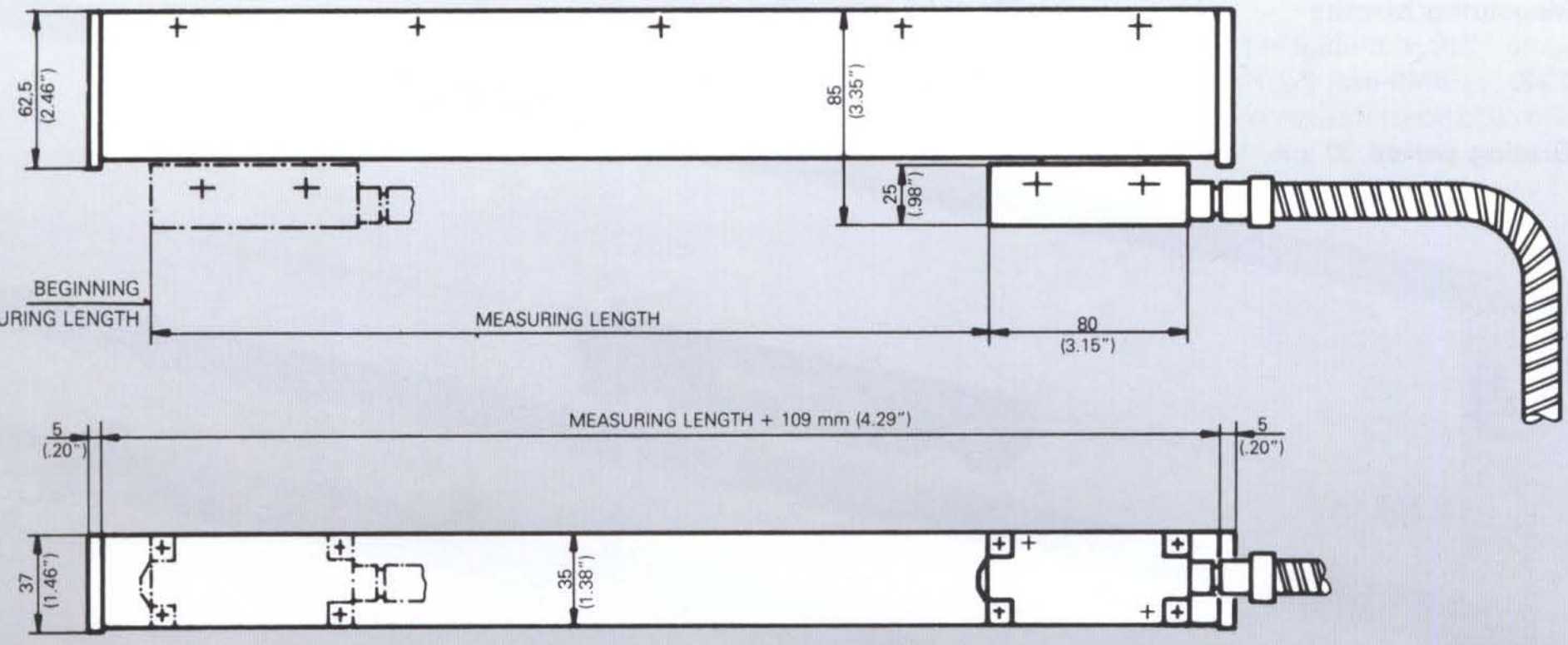
Standard Linear Encoders LS 107, LS 107 C – with sectional machine error compensation

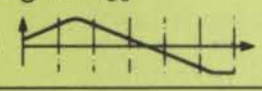
Incremental, sealed linear encoder
2 mounting attitudes
Measuring lengths up to 3040 mm (120 in.)
Grating period 20 µm
Accuracy grades ± 5 µm/± 3 µm/± 2 µm
(± 0.00020 in./± 0.00012 in./± 0.00008 in.)
Recommended measuring steps 1 µm/0.5 µm
(0.00005 in./0.00002 in.)
Reference marks LS 107: every 50 mm (2 in.), via selector magnets
LS 107 C: distance-coded
Machine error compensation
every 100 mm (4 in.) via linear guiders



Mechanical data		LS 107, LS 107 C
Measuring standard		Glass scale with DIADUR-grating Grating period 20 µm
Accuracy grades		± 5 µm/± 3 µm/± 2µm (± 0.00020 in./± 0.00012 in/± 0.0008 in.)
Machine error compensation		every 100 mm (4 in.) via linear guiders, max. ± 20 µm (± 0.0008 in.) per meas. length
Reference marks	LS 107 LS 107 C	every 50 mm (2 in.) possible (activated via selector magnets), distance-coded reference marks
Measuring lengths	mm inch	240/340/440/540/640/740/840/940/1040/1140/1240/1340/1440/1540/1640/1740/ 1840/2040/2240/2440/2640/2840/3040 9.5/13.4/17.3/21.3/25.2/29.0/33.0/37.0/41.0/44.9/48.8/52.7/56.7/60.6/ 64.6/68.5/72.4/80.3/88.2/96.0/104.0/112.0/120.0
Max. traversing speed		30 m/min (100 ft/min)
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)		 30 m/s^2 200 m/s^2
Required moving force		≦ 5 N
Operating temperature		0 ... 40°C (32 ... 104°F)
Storage temperature		–20 ... 70°C (–4 ... 158°F)
Weight		1 kg + 2.6 kg/m measuring length (2.2 lb + 1.74 lb/ft)
Connecting cable		3 m (10 ft), with connector and armored sheathing (standard)

Dimensions in mm (inch)



Electrical data		**LS 107, LS 107 C**
Light source		Miniature lamp 5 V/0.6 W
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2}
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

Miniaturized Sealed Linear Encoders
LS 403, LS 403 C
LS 404, LS 404 C

Incremental, sealed linear encoders with **miniature cross-section** (18 mm × 46 mm/.7 in. × 1.8 in.) for **limited installation space.**

LS 403/LS 403 C
Measuring lengths
up to 1240 mm (48.8 in.)
1340 ... 2040 mm (52.7 ... 80.3 in.)
with additional mounting spar
Grating period 20 µm

LS 404/LS 404 C
The glass scale is fixed to the left-hand end of the carrier (aluminum extrusion) to prevent displacement between the glass scale and the carrier during temperature changes.
Measuring lengths
up to 620 mm (24.4 in.)
Otherwise as with LS 403

Recommended measuring steps
1 µm/0.5 µm
(0.000 05 in./0.000 02 in.)

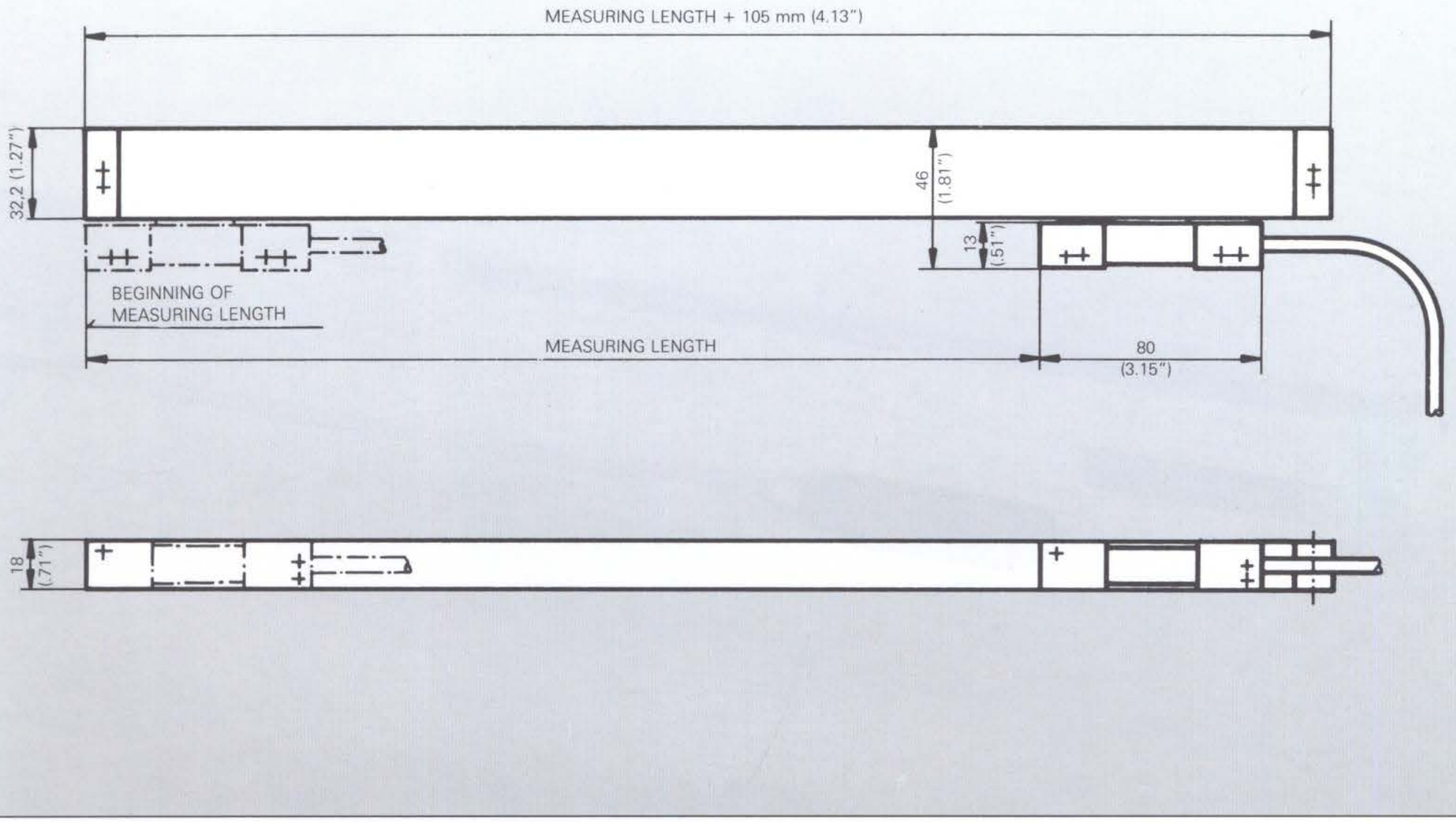
LS 403

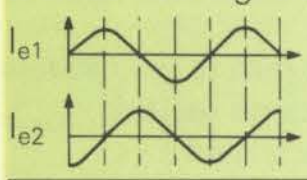
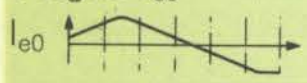
LS 404

LS 403 with mounting spar

Mechanical data			**LS 403, LS 403 C**	**LS 404, LS 404 C**
Measuring standard			Glass scale with DIADUR-grating Grating period 20 µm	
Accuracy grades			± 5 µm/± 3 µm up to 1240 mm (48.8 in.) only (± 0.00020 in./± 0.00012 in.)	
Reference marks (standard-type)	LS 403/LS 404		2 reference marks – with measuring lenghts up to 1020 mm (40.1 in.) each 35 mm (1.4 in.) from beginning and end of the measuring length – with measuring lenghts 1140 mm (44.9 in.) up to 2040 mm (80.3 in.) each 45 mm (1.8 in.) from beginning and end of the measuring length further reference mark locations on request	
	LS 403 C, LS 404 C		distance-coded reference marks	
Measuring lengths	LS 403, LS 403 C/ LS 404, LS 404 C	mm inch	70/120/170/220/270/320/370/420/470/520/570/620 2.7/4.7/6.7/8.6/10.6/12.6/14.5/16.5/18.5/20.5/22.4/24.4	
	LS 403, LS 403 C	mm inch	720/770/820/920/1020/1140/1240 28.3/30.3/32.3/36.2/40.1/44.9/48.8	
	LS 403, LS 403 C with mounting spar	mm inch	1340/1440/1540/1640/1740/1840/2040 52.7/56.7/60.6/64.6/68.5/72.4/80.3	
Max. traversing speed			48 m/min (160 ft/min)	
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)			30 m/s² 100 m/s² without mounting spar 200 m/s² with mounting spar (LS 403/LS 403 C only)	
Required moving force			≦ 6 N	
Operating temperature			0 ... 50°C (32 ... 122°F)	
Storage temperature			–20 ... 70°C (–4 ... 158°F)	–20 ... 50°C (–4 ... 122°F)
Weight			0.1 kg + 0.5 kg/m measuring length (0.22 lb + 0.34 lb/ft)	
Connecting cable			3 m (10 ft), with connector (standard); 0.3 m (1 ft), with flange socket (male) on mounting block (special type); 3 m (10 ft), with armored sheathing with connector (special type)	

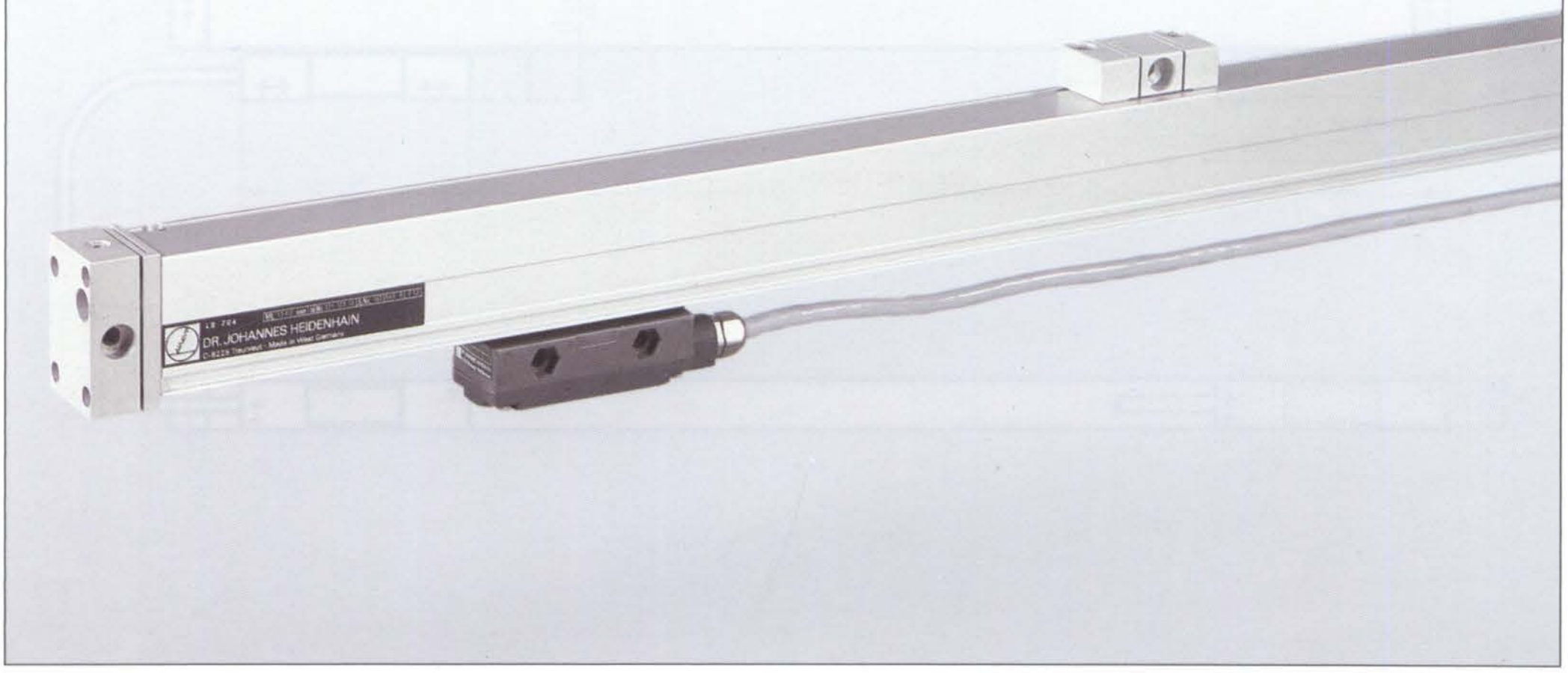
Dimensions in mm (inch)



Electrical data		LS 403, LS 403 C/LS 404, LS 404 C
Light source		Miniature lamp 5 V/0.6 W
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} 
	Reference signal	1 signal I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

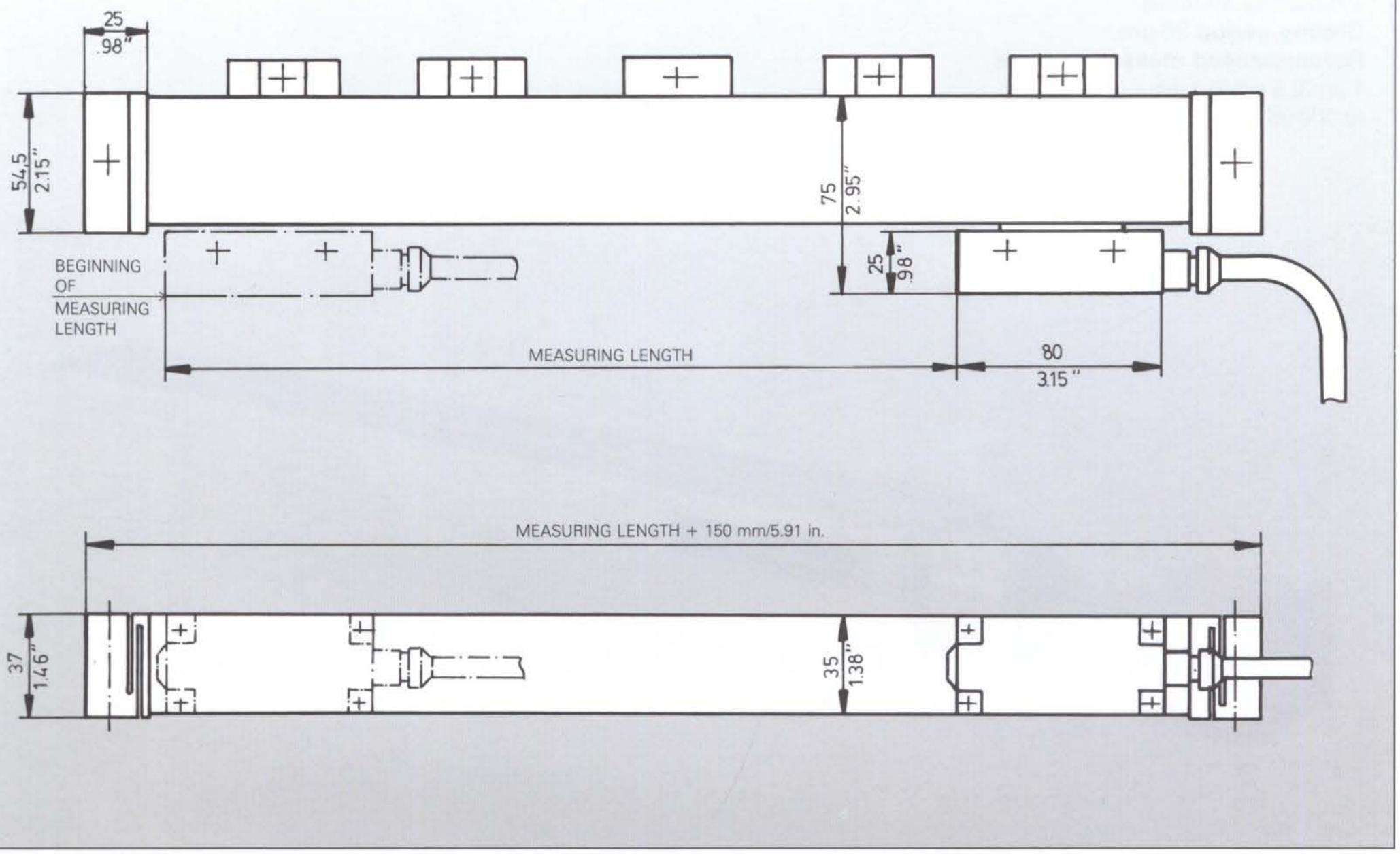
Standard Linear Encoders LS 704, LS 704 C robust design

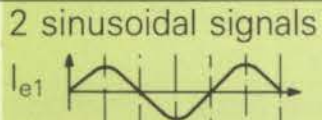
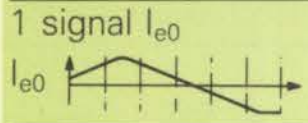
Incremental, sealed linear encoders
Measuring lengths up to 3040 mm (120.0 in.)
Grating period 20 µm
Recommended measuring steps 1 µm/0.5 µm
(0.000 05 in./0.000 02 in.)



Mechanical data		LS 704, LS 704 C
Measuring standard		Glass scale with DIADUR-grating Grating period 20 µm
Accuracy grades		± 5 µm/± 3 µm up to 1240 mm (48.8 in.) only (± 0.00020 in./± 0.000 12 in.)
Reference marks	LS 704	One reference mark at mid-point of measuring length (standard) or several reference marks on 50 mm (2 in.) module from mid-point of measuring length. Further reference marks on request
	LS 704 C	distance-coded reference marks
Measuring lengths	mm	170/220/270/320/370/420/470/520/620/720/770/820/920/1020/1140/1240/1340/1440/1540/1640/1740/1840/2040/2240/2440/2640/2840/3040
	inch	6.7/8.6/10.6/12.6/14.5/16.5/18.5/20.5/24.4/28.3/30.3/32.3/36.2/40.1/44.9/48.8/52.7/56.7/60.6/64.6/68.5/72.4/80.3/88.2/96.0/104.0/112.0/120.0
Max. traversing speed		48 m/min (160 ft/min)
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)		 30 m/s^2 200 m/s^2
Required moving force		≦ 10 N
Operating temperature		0 ... 50°C (32 ... 122°F)
Storage temperature		–20 ... 70°C (–4 ... 158°F)
Weigth		0.7 kg + 2 kg/m measuring length (1.54 lb + 1.34 lb/ft)
Connecting cable		3 m (10 ft), with connector (standard); 0.3 m (1 ft), with flange socket (male) on mounting block (special type); 3 m (10 ft), with armored sheathing with connector (special type)

Dimensions in mm/inch



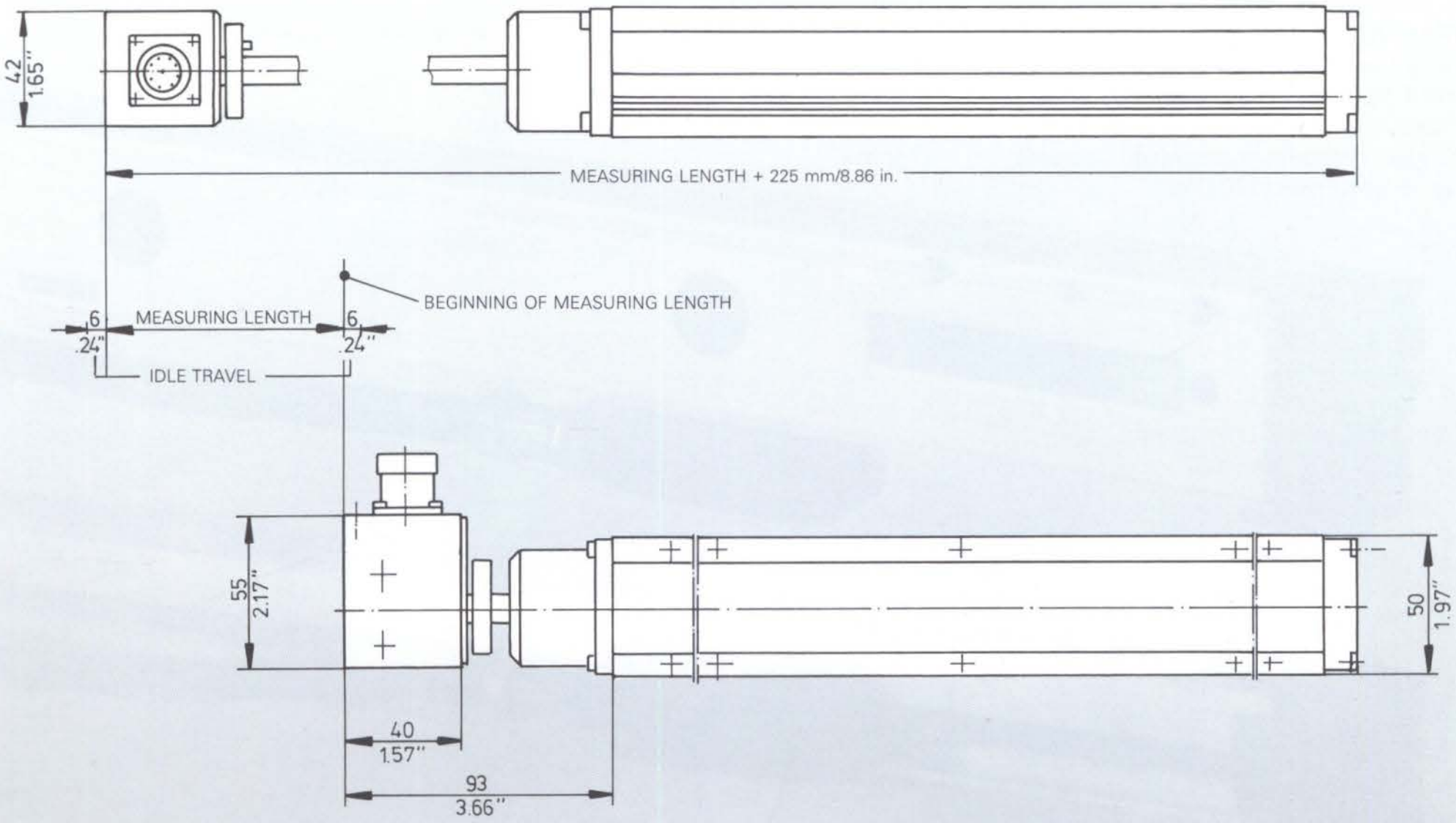
Electrical data		**LS 704, LS 704 C**
Light source		Miniature lamp 5 V/0.6 W
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2} 
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

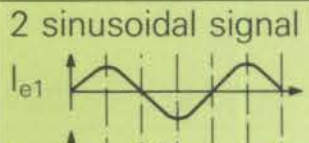
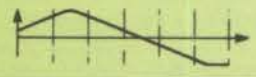
Completely Sealed Linear Encoders
ULS 300, ULS 300 C

Incremental, completely encapsulated
linear encoder with push-rod activation
2 mounting attitudes
Grating period 20 µm
Recommended measuring steps
1 µm/0.5 µm/0.2 µm
(0.000 05 in./0.000 02 in./0.000 01 in.)

Mechanical data		**ULS 300, ULS 300 C**
Measuring standard		Glass scale with DIADUR-grating Grating period 20 µm
Accuracy grades		± 3 µm (± 0.000 12 in.)/2 µm (± 0.000 08 in.) measuring lengths 170 mm (6.7 in.) and 270 mm (10.6 in.) only
Reference mark	ULS 300	Standard: one reference mark at mid-point of traverse or several reference marks on 50 mm (2 in.) module from mid-point of measuring length Special type: one reference mark at any desired location
	ULS 300 C	distance-coded
Measuring lengths	mm	170/270/370/520
	inch	6.7/10.6/14.5/20.5
Max. traversing speed		30 m/min (100 ft/min)
Permissible acceleration max. vibration (50 ... 2000 Hz) max. shock (11 ms)		 30 m/s² 200 m/s²
Required moving force		1 ... 3 N
Permissible guideway error of connected slide		± 0.5 mm (± 0.02 in.)
Operating temperature		0 ... 50 °C (32 ... 122 °F)
Storage temperature		–20 ... 70 °C (–4 ... 158 °F)
Weight		1.25 kg (2.75 lb) + 0.15 kg/100 mm (1.0 lb/ft) measuring length

Dimensions in mm/inch

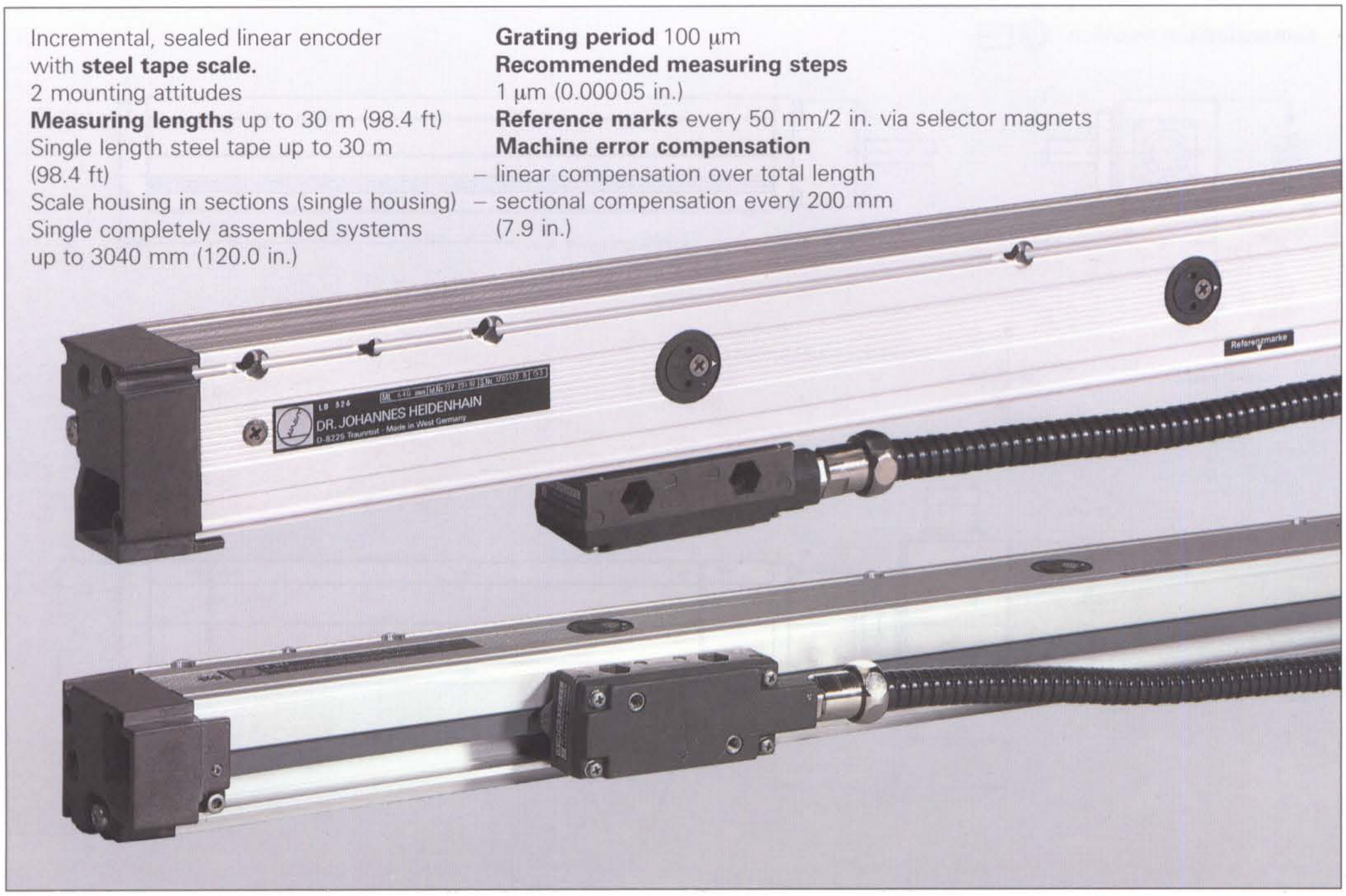


Electrical data		ULS 300, ULS 300 C
Light source		LED
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signal I_{e1} and I_{e2} I_{e1}  I_{e2}
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

Sealed Linear Encoder for large traverses LB 326 with machine error compensation

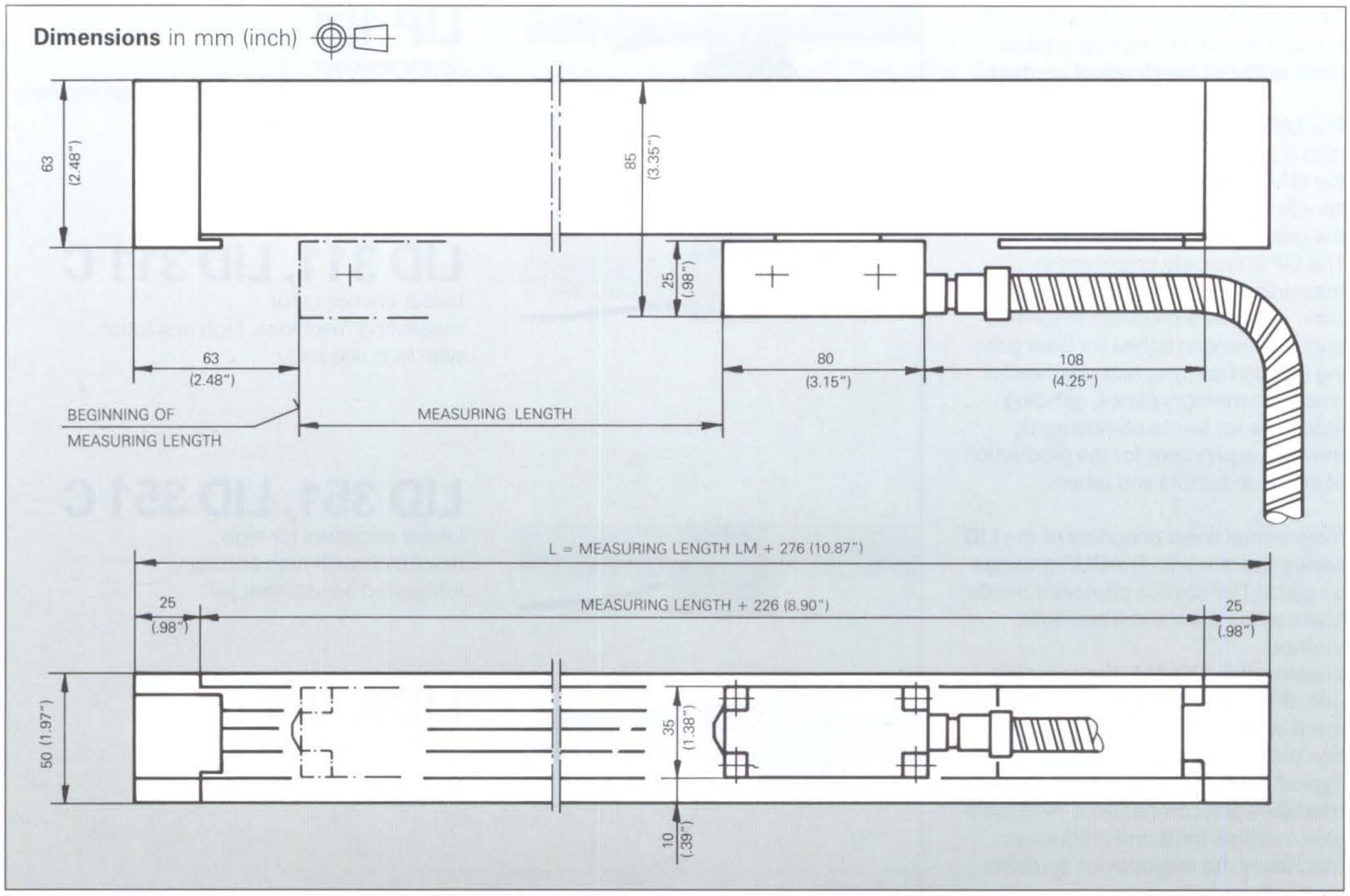
Incremental, sealed linear encoder
with **steel tape scale.**
2 mounting attitudes
Measuring lengths up to 30 m (98.4 ft)
Single length steel tape up to 30 m (98.4 ft)
Scale housing in sections (single housing)
Single completely assembled systems up to 3040 mm (120.0 in.)

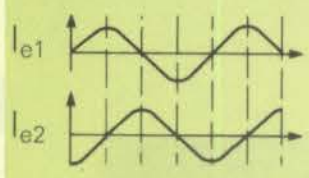
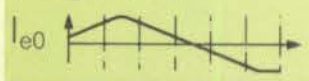
Grating period 100 µm
Recommended measuring steps
1 µm (0.00005 in.)
Reference marks every 50 mm/2 in. via selector magnets
Machine error compensation
– linear compensation over total length
– sectional compensation every 200 mm (7.9 in.)



Mechanical data	LB 326
Measuring standard	Stainless steel tape scale with AURODUR-grating Grating period 100 µm
Accuracy grades	. single system (up to 3040 mm/120.0 in.) ± 5 µm with ± 2 µm/200 mm (± 0.00020 in. ± 0.00008 in./7.9 in.) . multi-section system (over 3040 mm/120 in.) ± 5 µm (± 0.00020 in.)
Machine error compensation	1) with tape tensioning screw; range max. ± 100 µm/m (± 100 ppm) 2) by setting correction discs (every 200 mm, 7.9 in.); range ± 20 µm (0.0008 in.) per meas. length, max. ± 10 µm/200 mm (± 50 ppm)
Reference marks	every 50 mm/2 in. (selector magnets)
Measuring lengths mm inch	Single completely assembled systems: 440/640/840/1040/1240/1440/1640/1840/2040/2240/2440/2640/2840/3040 17.3/25.2/33.0/41.0/48.8/56.7/64.6/72.4/80.3/88.2/96.0/104.0/112.0/120.0
	Kit comprising single-length AURODUR scale and housing section lengths for measuring lengths up to 30 000 mm (98.4 ft) Housing section lengths: 1000, 1200, 1400, 1600, 1800 and 2000 mm (39.4/47.2/55.1/63.0/70.9/78.7 in.)
Max. traversing speed	60 m/min (200 ft/min)
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)	 60 m/s² 1000 m/s² for measuring lengths up to 3040 mm (120.0 in.) 400 m/s² for measuring lengths over 3040 mm (120.0 in.)
Required moving force	≦ 15 N
Operating temperature	0 ... 45°C (32 ... 113°F)
Storage temperature	–20 ... 70°C (–4 ... 158°F)
Weight	1.8 kg + 3.3 kg/m measuring length (4.0 lb + 2.2 lb/ft)
Connecting cable	3 m (10 ft), with connector and armored sheathing (standard); 0.5 m (1.7 ft), with connector (special type); 1.5 m (5 ft), without connector (special type)

Dimensions in mm (inch)



Electrical data		LB 326
Light source		LED
Operating voltage for light source and switching circuit for reference mark selection		5 V ± 5 %/140 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} 
	Reference signal	1 signal I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

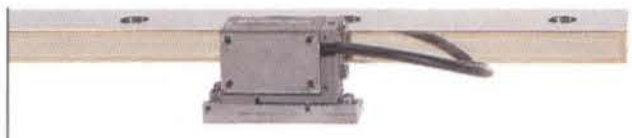
"Exposed" Linear Encoders

On exposed linear encoders the scale is unprotected. The scanning takes place **without mechanical contact.**

The **LIP 101** linear encoder operates with a phase grating applied to steel in the GALVADUR process. A glass lamella secured with cement protects the grating from contamination.
The LIP is typically employed in measuring machines, measuring microscopes, ultra-precision machines such as diamond lathes for laser printing polygon mirrors, facing lathes for magnetic memory plates, grinding machines for ferrite components, masking equipment for the production of semiconductors and others.

Incremental linear encoders of the **LID series** operate with DIADUR gratings on glass. The scale is photoelectrically scanned via the transmitted light method.
In contrast to LID 311, the scanning unit of the LID 351 includes an adjustment aid which enables easy installation with less expense.
Typical applications are measuring machines and comparators, high precision machine tools and production machinery, for example for semiconductor manufacture.

Incremental linear encoders of the **LIDA series** operate with AURODUR gratings on steel. The scale is photoelectrically scanned via the reflected light method.
LIDA 190 and LIDA 201 have grating periods of 40 µm and 100 µm, respectively. The electronic interpolation must therefore be greater for the LIDA 201 than for the LIDA 190 in order to achieve a certain measuring step. However the tolerances for the clearance between scale and scanning unit on the LIDA 190 are considerably smaller.
The quality of the machine guide is therefore of utmost importance in deciding which of the two units to employ.
Typical applications are coordinate measuring machines, test equipment, type setting machines, automatic component insertion machines, PCB drilling machines, precision handling equipment and others.



LIP 101

Linear encoder
. for highest resolution with very high accuracy
. for ultra precision machines

LID 311, LID 311 C

Linear encoders for
measuring machines, high resolution
with high accuracy

LID 351, LID 351 C

Linear encoders for high
resolution with high accuracy,
integrated adjustment aid

LIDA 190

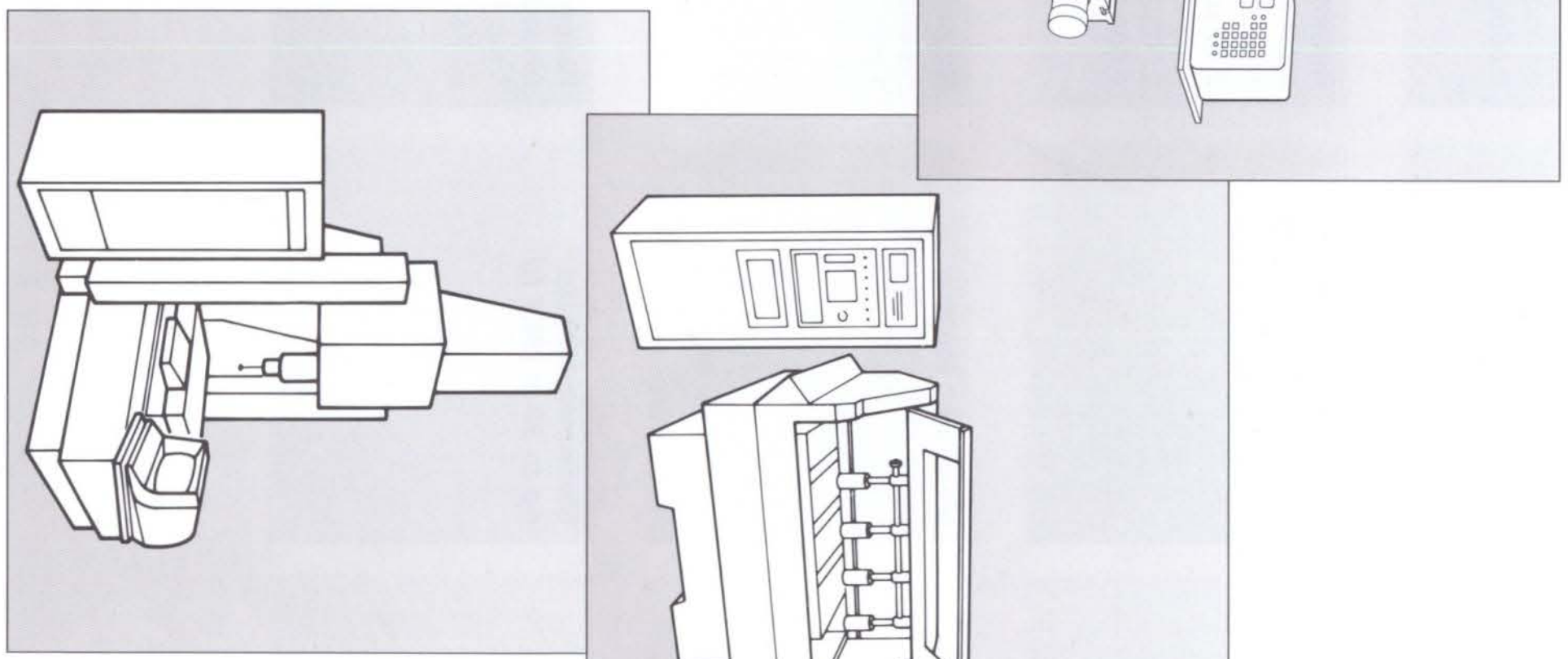
Linear encoder with
reference mark positions
as required

LIDA 201

Linear encoder with
large installation tolerances

LIDA 225

Linear encoder
. for large traverses
. with linear machine error
compensation

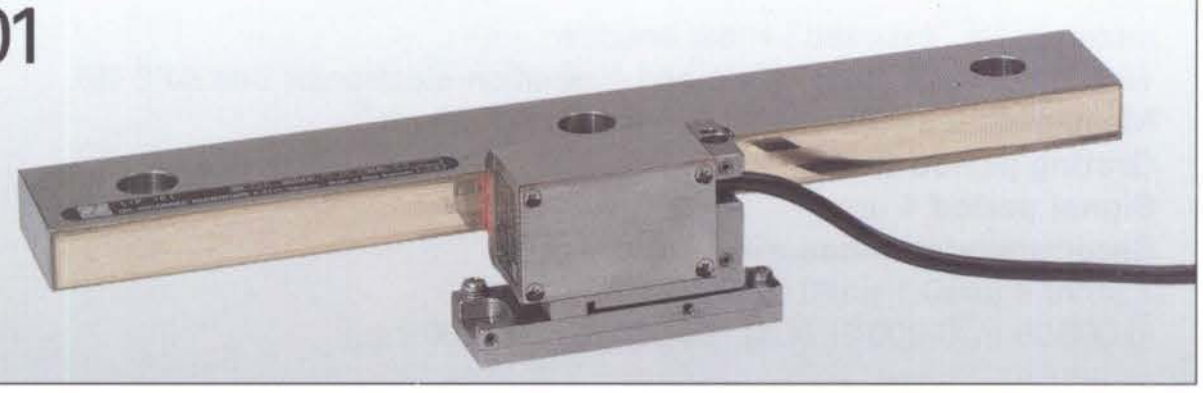


"Exposed" Linear Encoders

Measuring standard GALVADUR steel scale	**Measuring lengths** up to 1020 mm (40.1 in.)	**Recommended measuring steps** 1 µm/0.2 µm/0.1 µm/ ***0.02 µm*** (0.00005 in./0.00001 in./ 0.000005 in./***0.000001 in.***)	**Accuracy grades** ± 2 µm (± 0.00008 in.) ± 1 µm (± 0.00004 in.) ***± 0.5 µm (± 0.00002 in.)*** up to 520 mm (20.5 in.) only ***± 0.2 µm (± 0.00001 in.)*** up to 220 mm (8.6 in.) only
Measuring standard DIADUR glass scale	**Measuring lengths** up to 1500 mm (59.0 in.)	**Recommended measuring steps** 1 µm/0.5 µm/0.2 µm/0.1 µm/ ***0.05 µm*** (0.00005 in./0.00002 in./ 0.00001 in., 0.000005 in., ***0.000002 in.***)	**Accuracy grades** ± 1 µm (± 0.00004 in.) ***± 0.5 µm (± 0.00002 in.)*** up to 500 mm (19.7 in.) only ***± 0.2 µm (± 0.00001 in.)*** up to 200 mm (7.9 in.) only
Measuring standard DIADUR glass scale	**Measuring lengths** up to 1500 mm (59.0 in.)	**Recommended measuring steps** 1 µm/0.5 µm/0.2 µm/0.1 µm/ ***0.05 µm*** (0.00005 in./0.00002 in./ 0.00001 in., 0.000005 in., ***0.000002 in.***)	**Accuracy grades** ± 1 µm (± 0.00004 in.) ***± 0.5 µm (± 0.00002 in.)*** up to 500 mm (19.7 in.) only ***± 0.2 µm (± 0.00001 in.)*** up to 200 mm (7.9 in.) only
Measuring standard AURODUR steel scale	**Measuring lengths** up to 2040 mm (80.3 in.)	**Recommended measuring step** 1 µm (0.00005 in.)	**Accuracy grades** ± 5 µm (± 0.00020 in.) ± 3 µm (± 0.00012 in.)
Measuring standard AURODUR steel scale	**Measuring lengths** ***up to 30 m (98.4 ft)***	**Recommended measuring step** 1 µm (0.00005 in.)	**Accuracy grade** ± 5 µm (± 0.00020 in.)

. Clearance between scale and scanning head 1 ± 0.5 mm (0.039 ± 0.02 in.)

LIP 101



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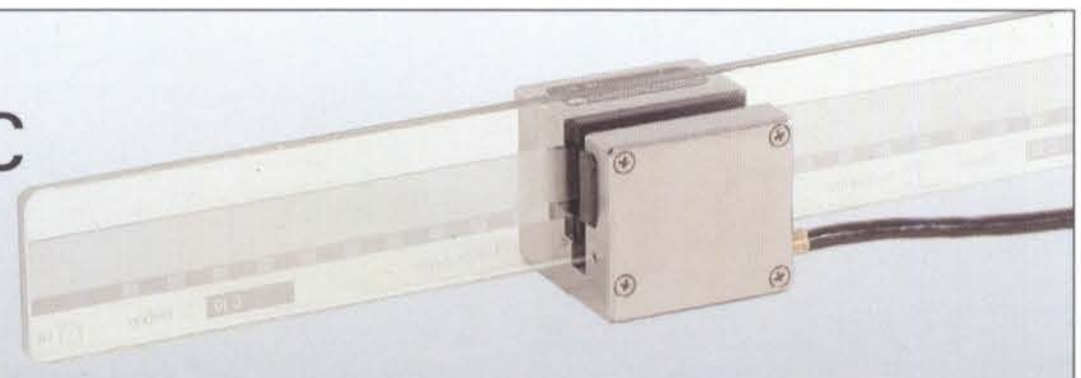
. Clearance between scale and scanning head 0.095 ± 0.015 mm (0.0037 ± 0.0006 in.)
. LID 311 C: distance-coded reference marks

LID 311
LID 311 C



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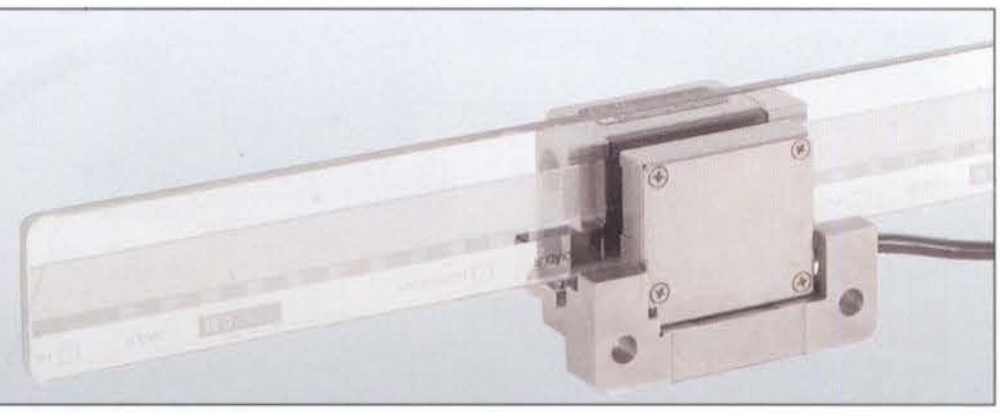
. Clearance between scale and scanning head 0.095 ± 0.015 mm (0.0037 ± 0.0006 in.)
. *Easy installation with integrated adjustment aid*
. LID 350 C: distance-coded reference marks

LID 351
LID 351 C



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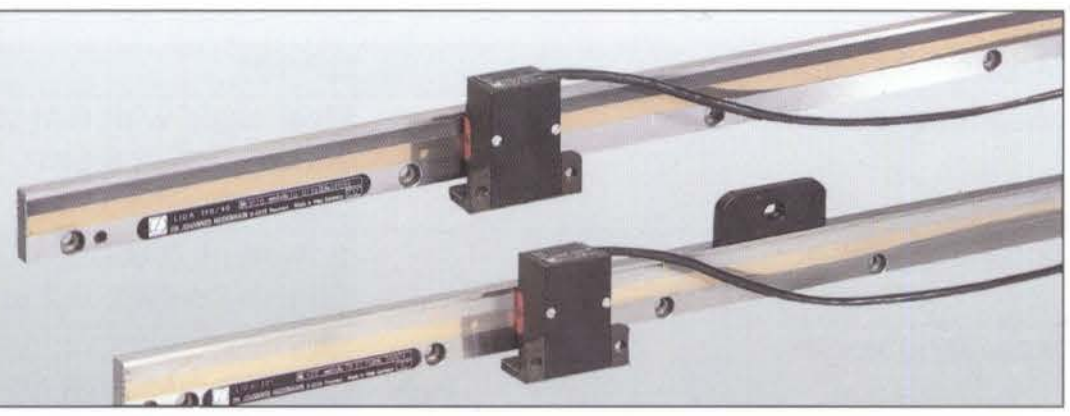
. LIDA 190: Clearance between scale and scanning head 0.1 ± 0.05 mm (0.0039 ± 0.0020 in.)
. reference mark positions as required
. LIDA 201: Large installation tolerances. Clearance between scale and scanning head 0.8 ± 0.2 mm (0.031 ± 0.008 in.)

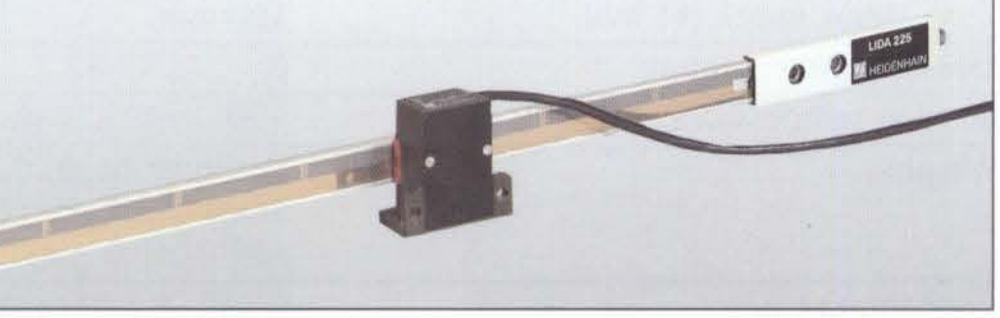
LIDA 190
LIDA 201



Page 38 and 40

. *Compensation of linear machine errors* by tape tensioning
. Clearance between scale and scanning head 0.2 ± 0.05 mm (0.008 ± 0.002 in.)

LIDA 225



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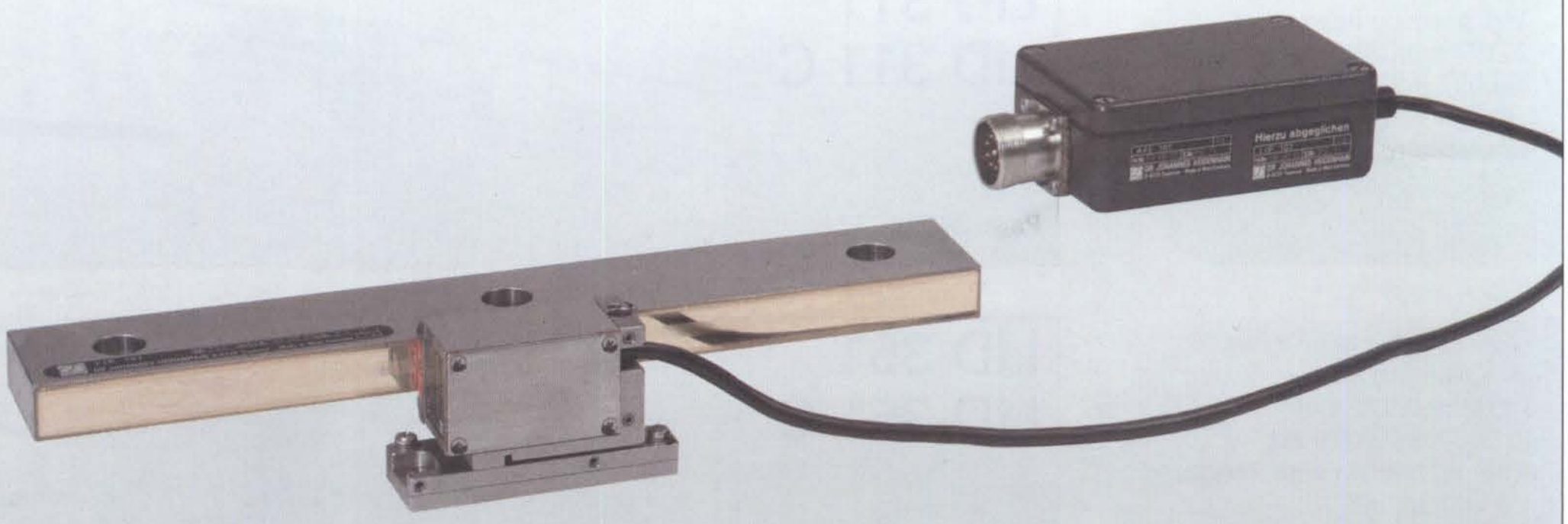
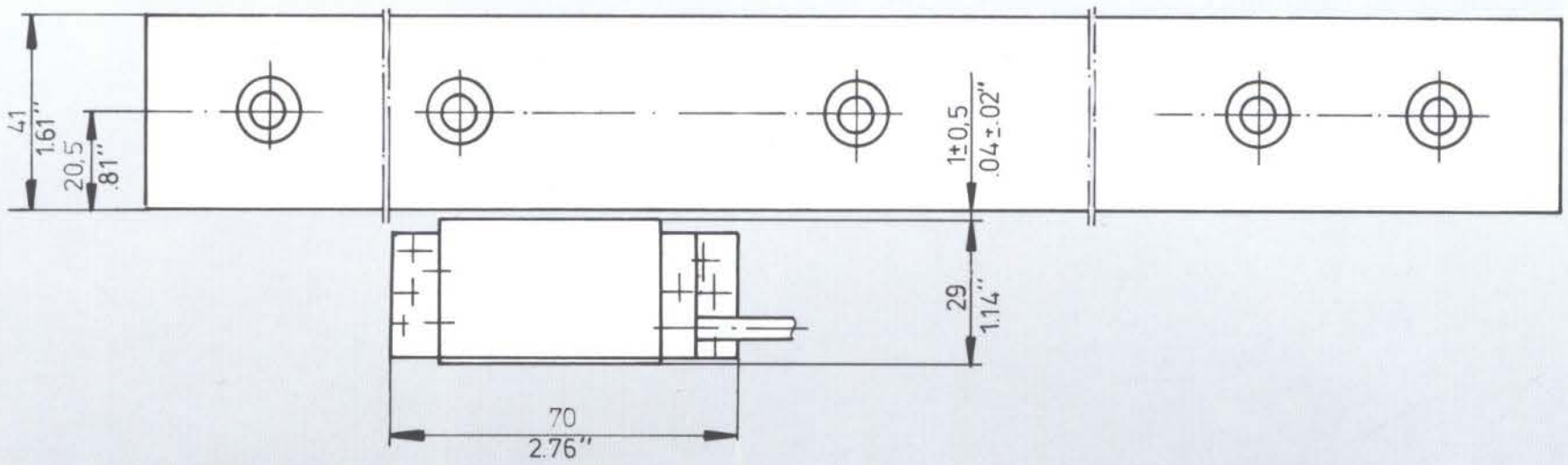
"Exposed" Linear Encoder LIP 101 for very high resolutions with high accuracy

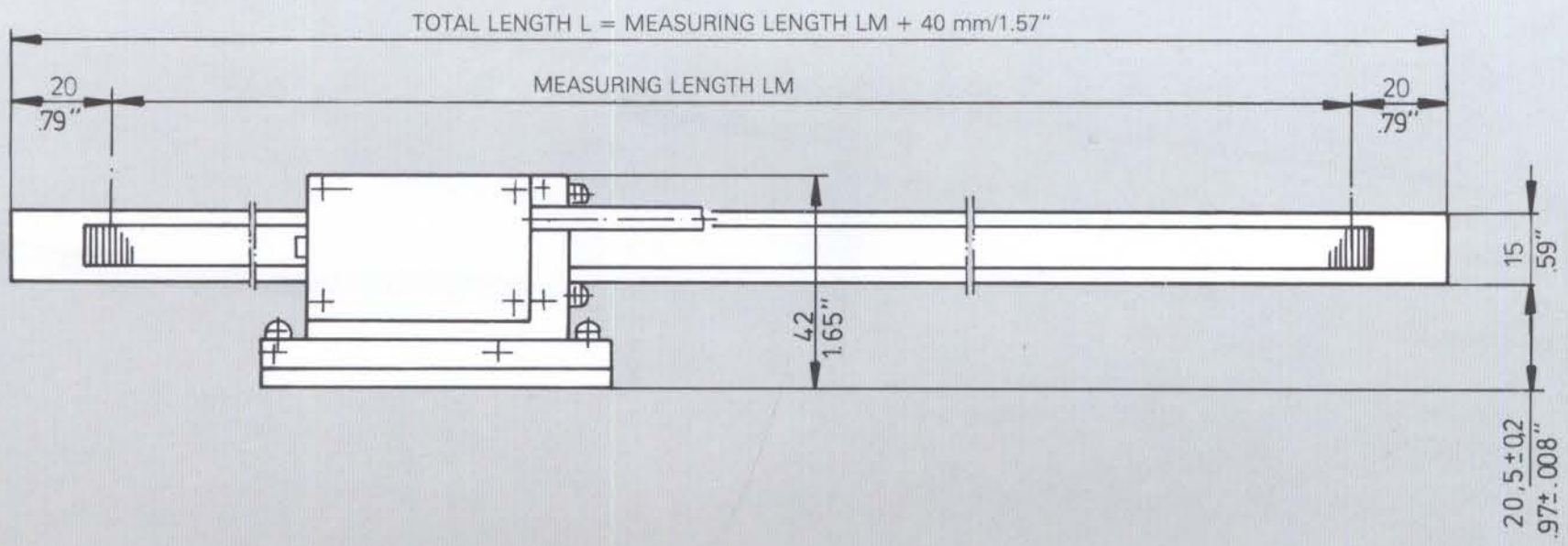
Incremental "exposed" linear encoder
with GALVADUR steel scale and evaluation electronics unit APE 101
Measuring lengths up to 1020 mm (40.1 in.)
Grating period 8 µm
Signal period 4 µm
Recommended measuring steps
1 µm/0.2 µm/0.1 µm/0.02 µm
(0.00005 in./0.00001 in./0.000005 in./0.000001 in.)

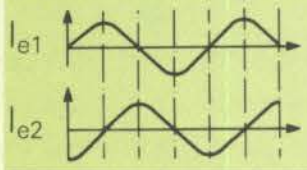


Mechanical data		LIP 101
Measuring standard		Steel scale with GALVADUR-grating Grating period 8 µm Signal period 4 µm
Accuracy grades		± 2 µm (± 0.00008 in.)/± 1 µm (± 0.00004 in.)/± 0.5 µm (± 0.00002 in.) up to 520 mm (20.5 in.) only/± 0.2 µm (± 0.00001 in.) up to 220 mm (8.6 in.) only
Measuring lengths	mm inch	120/170/220/320/420/520/620/720/820/920/1020 4.7/6.7/8.6/12.6/16.5/20.5/24.4/28.3/32.3/36.2/40.1
Max. traversing speed		depends on subsequent electronics
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)		 8 m/s² 100 m/s²
Operating temperature		0 ... 45°C (32 ... 113°F)
Storage temperature		–20 ... 70°C (–4 ... 158°F)
Weight		Scanning head: 0.3 kg (0.66 lb) Scale: 4.5 kg/m (3.0 lb/ft) APE 101: 0.3 kg (0.66 lb)
Connecting cable		0.5 m (1.7 ft) cable between scanning head and APE 101 Flange socket (9 pole) on APE 101

Dimensions in mm/inch





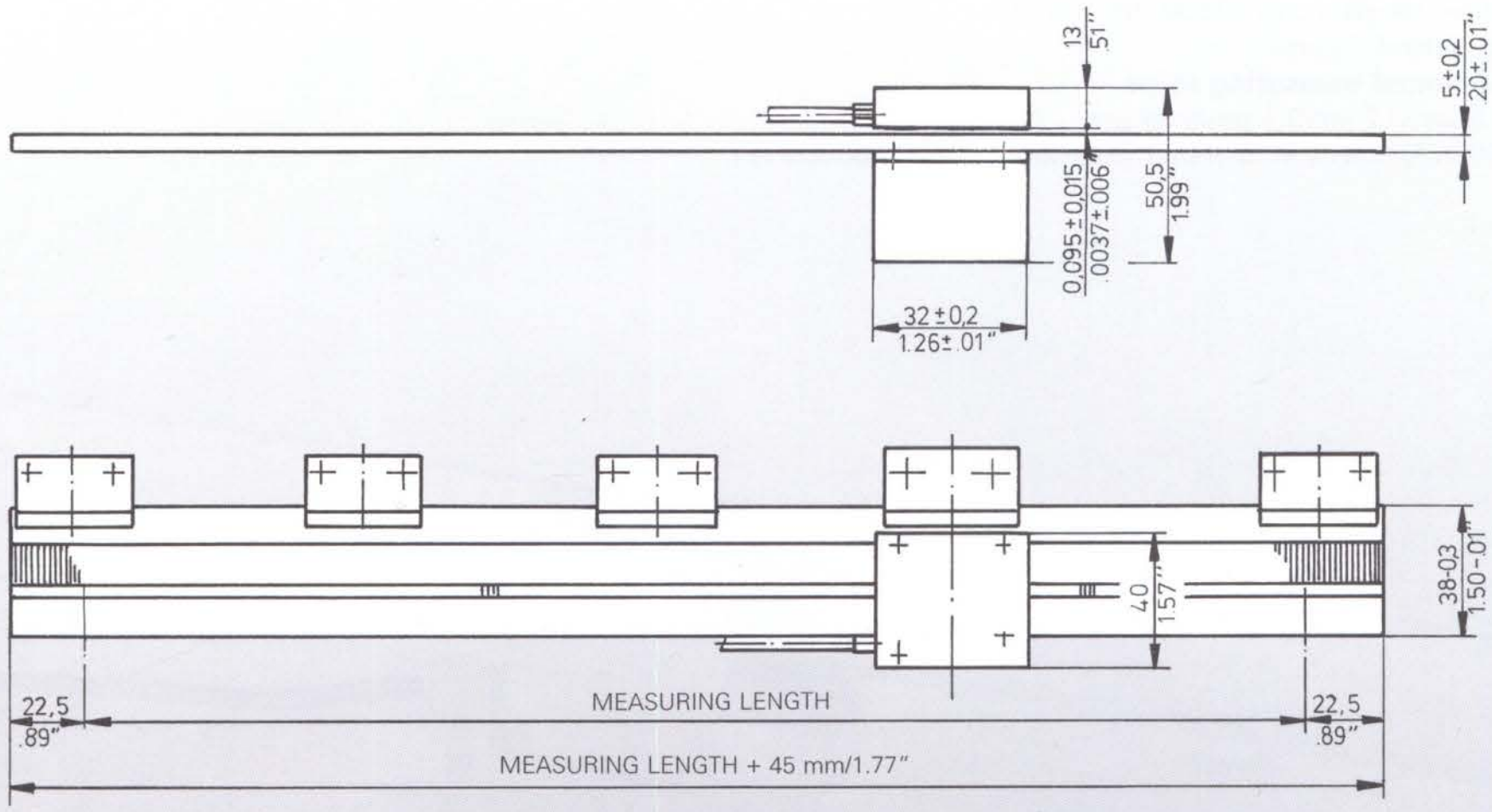
Electrical data		LIP 101
Light source		LED
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signal I_{e1} und I_{e2} 
	Signal level with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp}
Total permissible cable length		20 m (65.6 ft)

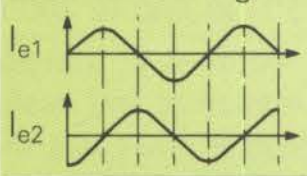
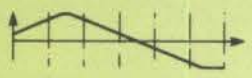
"Exposed" Linear Encoders (transmitted light)
LID 311, LID 311 C for high resolution with high accuracy

Incremental "exposed" linear encoder
with DIADUR glass scale
Measuring lengths up to 1500 mm
(59.0 in.)
Grating period 10 µm
Recommended measuring steps
1 µm/0.5 µm/0.2 µm/0.1 µm/0.05 µm
(0.00005 in./0.00002 in./0.00001 in./0.000005 in./0.000002 in.)

Mechanical data		**LID 311, LID 311 C**
Measuring standard		Glass scale with DIADUR-grating Grating period 10 µm
Accuracy grades		± 1 µm (± 0.00004 in.)/± 0.5 µm (± 0.00002 in.) up to 500 mm (19.7 in.) meas. length only/± 0.2 µm (± 0.00001 in.) up to 200 mm (7.9 in.) meas. length only
Reference marks	LID 311	– Standard: one reference mark at mid-point of measuring length – Special type: one reference at any desired location or several reference marks at 20 mm (0.8 in.) spacings or multiples thereof
	LID 311 C	distance-coded
Measuring lengths	mm	50/70/120/170/220/270/320/370/420/470/520/570/620/670/720/770/820/870/920/970/1020/1140/1240/1340/1440/1500
	inch	2.0/2.7/4.7/6.7/8.6/10.6/12.6/14.5/16.5/18.5/20.5/22.4/24.4/26.4/28.3/30.3/32.3/36.2/40.1/44.9/48.8/52.7/56.7/59.0
Max. traversing speed		depends on subsequent electronics
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)		 8 m/s² with resolution 0.5 µm (0.000002 in.) up to 0.5 µm (0.00002 in.) 50 m/s² with resolution 1 µm (0.00005 in.) and greater 100 m/s²
Operating temperature		0 ... 50 °C (32 ... 122 °F)
Storage temperature		–20 ... 70 °C (–4 ... 158 °F)
Weight		Scanning head 0.3 kg (0.66 lb) Scale 0.5 kg/m (0.34 lb/ft)
Connecting cable		3 m (10 ft), with connector

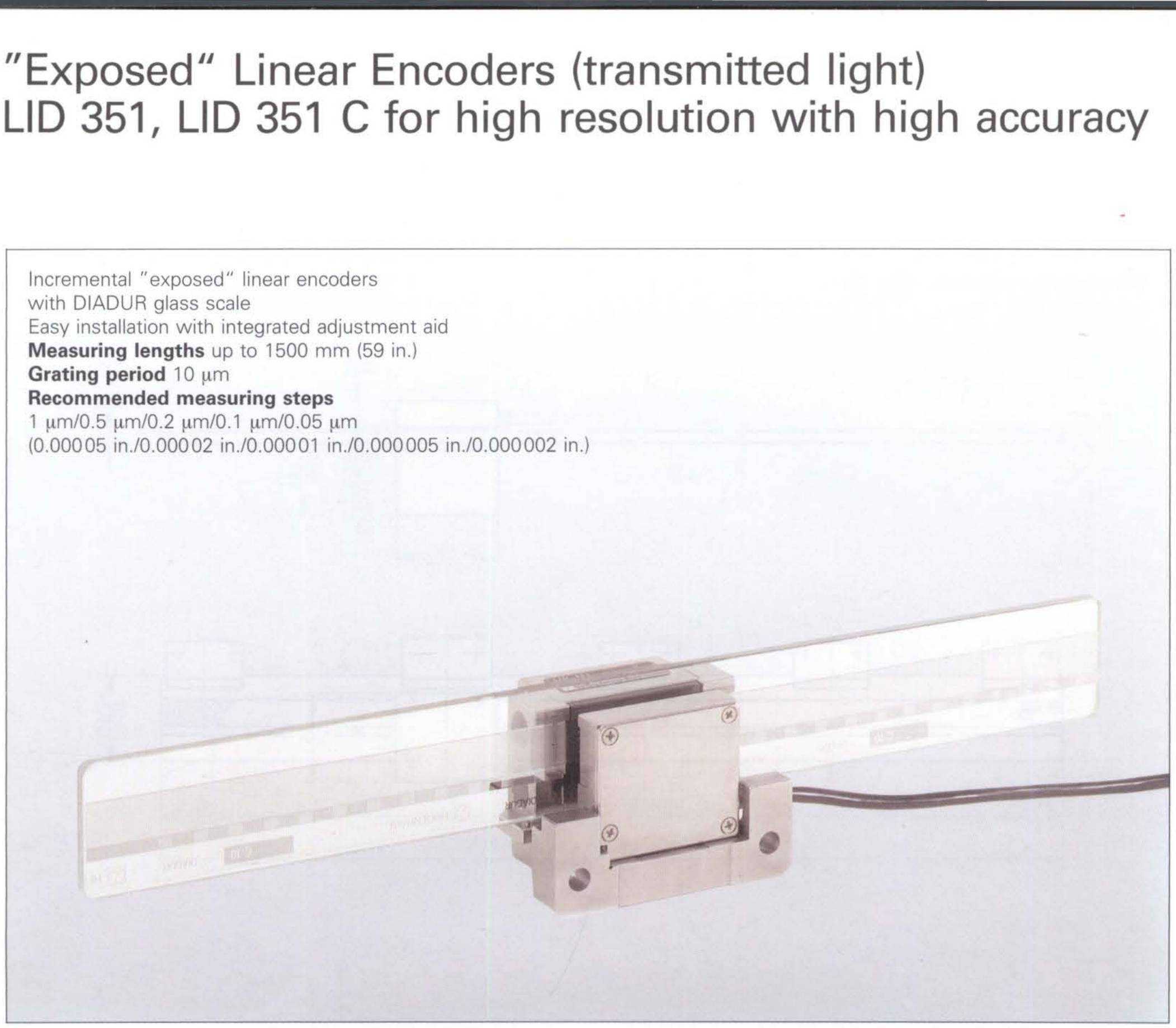
Dimensions in mm/inch



Electrical data		**LID 311, LID 311 C**
Light source		LED
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2}
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 … 16 μA_{pp} I_{e2} approx. 7 … 16 μA_{pp} I_{e0} approx. 2 … 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

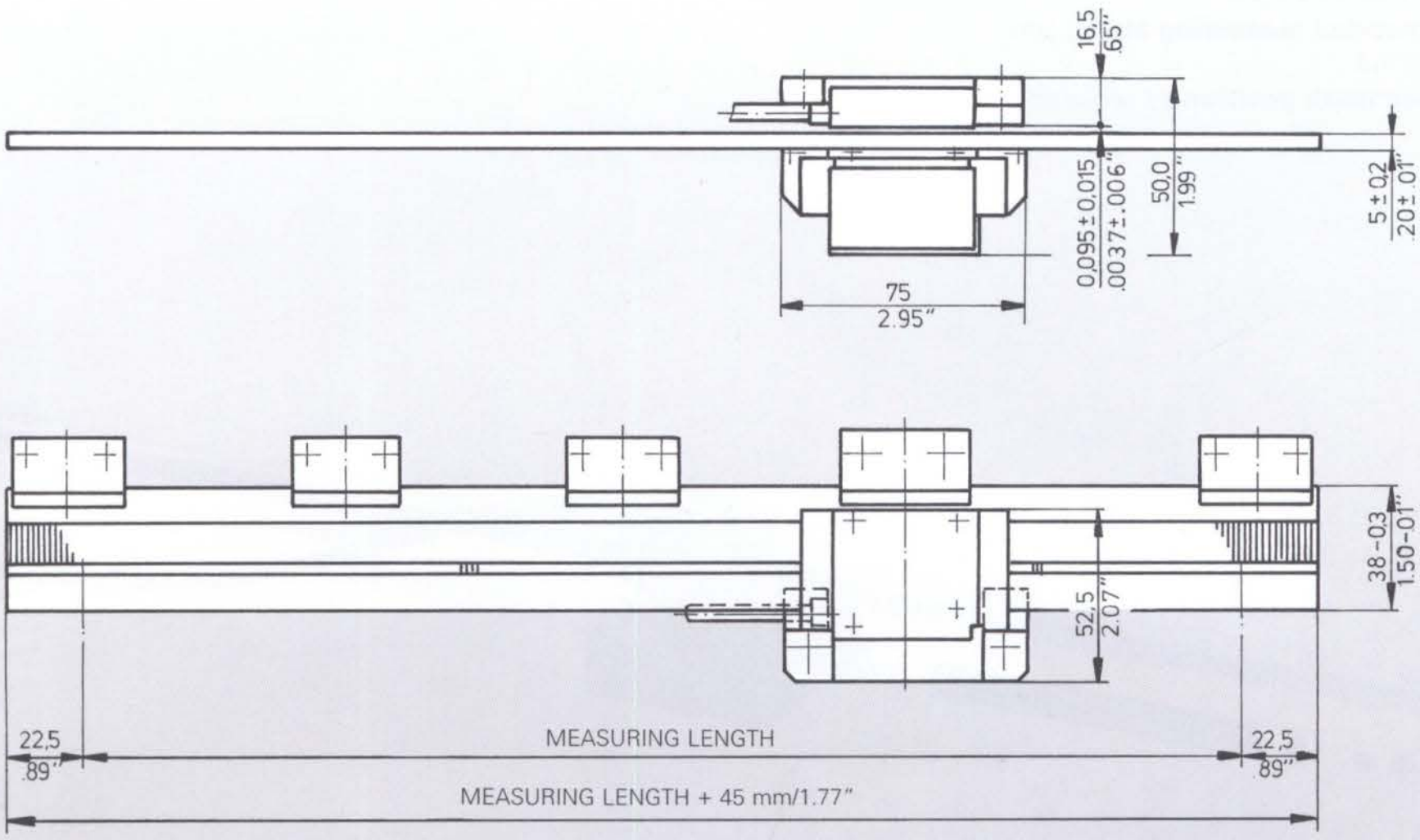
"Exposed" Linear Encoders (transmitted light)
LID 351, LID 351 C for high resolution with high accuracy

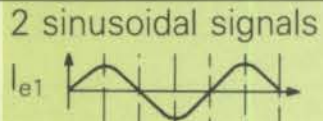
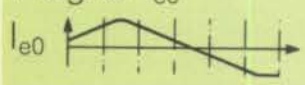
Incremental "exposed" linear encoders
with DIADUR glass scale
Easy installation with integrated adjustment aid
Measuring lengths up to 1500 mm (59 in.)
Grating period 10 µm
Recommended measuring steps
1 µm/0.5 µm/0.2 µm/0.1 µm/0.05 µm
(0.00005 in./0.00002 in./0.00001 in./0.000005 in./0.000002 in.)



Mechanical data		**LID 351, LID 351 C**
Measuring standard		Glass scale with DIADUR-grating Grating period 10 µm
Accuracy grades		± 1 µm (± 0.00004 in.)/± 0.5 µm (± 0.00002 in.) up to 500 mm (19.7 in.) meas. length only/± 0.2 µm (± 0.00001 in.) up to 200 mm (7.9 in.) meas. length only
Reference marks	LID 351	– Standard: one reference mark at mid-point of measuring length – Special type: one reference at any desired location or several reference marks at 20 mm (0.8 in.) spacings or multiples thereof
	LID 351 C	distance-coded
Measuring lengths	mm	50/70/120/170/220/270/320/370/420/470/520/570/620/670/720/770/820/870/920/970/1020/1140/1240/1340/1440/1500
	inch	2.0/2.7/4.7/6.7/8.6/10.6/12.6/14.5/16.5/18.5/20.5/22.4/24.4/26.4/28.3/30.3/32.3/36.2/40.1/44.9/48.8/52.7/56.7/59.0
Max. traversing speed		depends on subsequent electronics
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)		 8 m/s² with resolution 0.05 µm (0.000002 in.) up to 0.5 µm (0.00002 in.) 50 m/s² with resolution 1 µm (0.00005 in.) and greater 100 m/s²
Operating temperature		0 ... 50 °C (32 ... 122 °F)
Storage temperature		–20 ... 70 °C (–4 ... 158 °F)
Weight		Scanning head 0.85 kg (1.87 lb) Scale 0.5 kg/m (0.34 lb/ft)
Connecting cable		3 m (10 ft), with connector

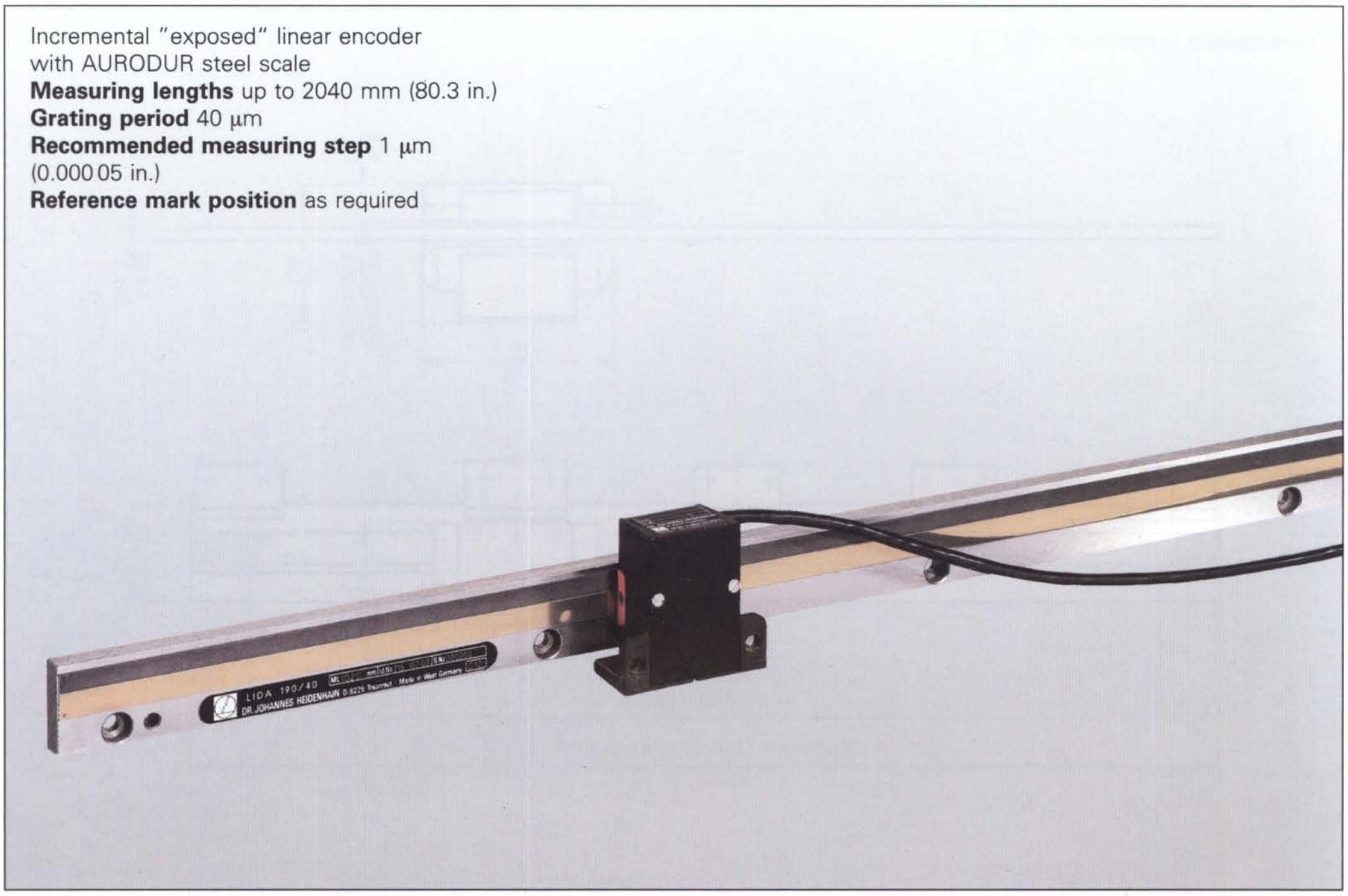
Dimensions in mm/inch



Electrical data		**LID 351, LID 351 C**
Light source		LED
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2} 
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

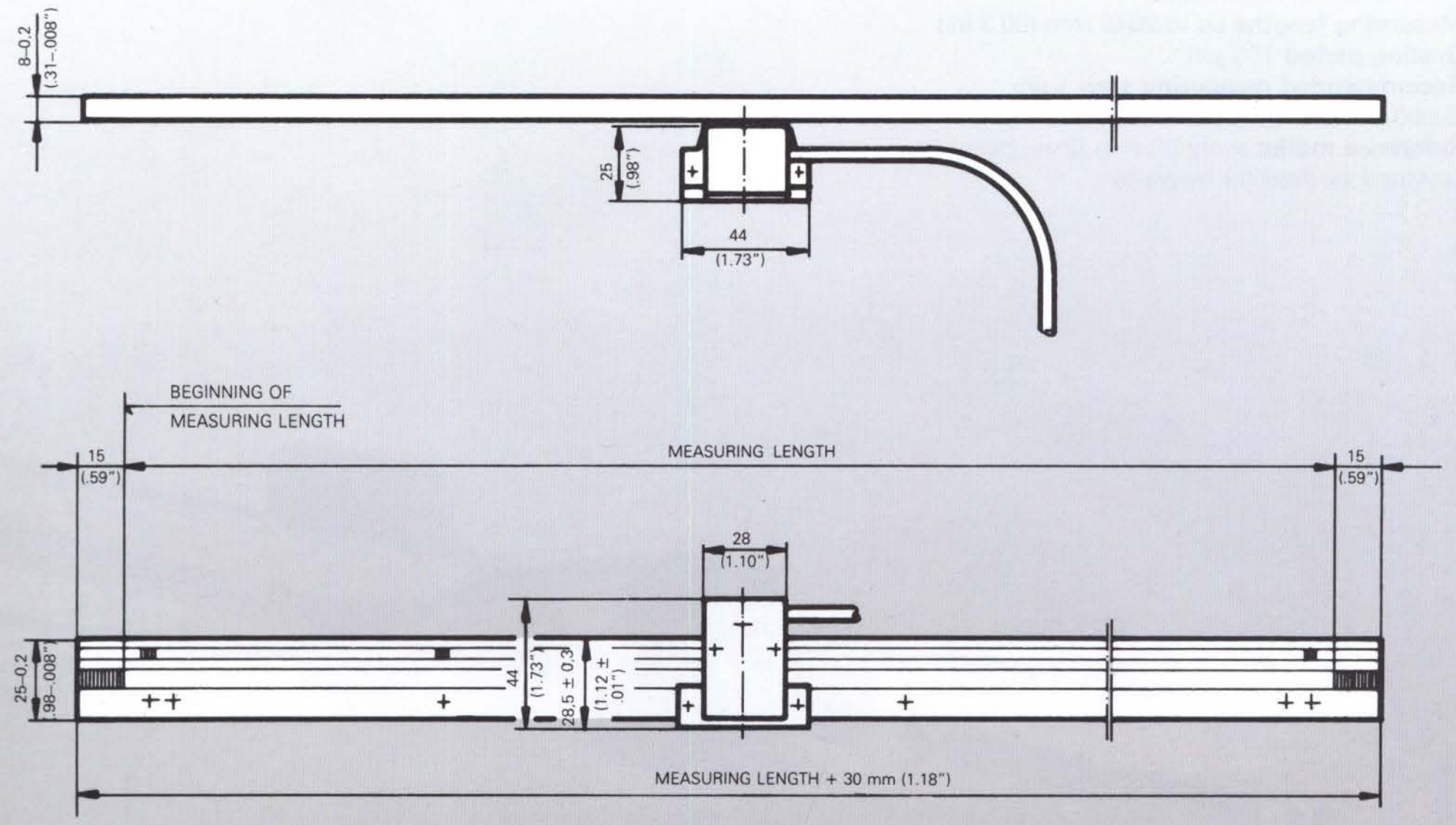
"Exposed" Linear Encoder (reflected light) LIDA 190

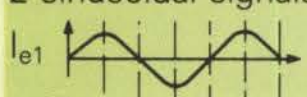
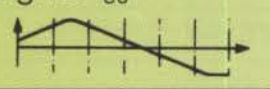
Incremental "exposed" linear encoder
with AURODUR steel scale
Measuring lengths up to 2040 mm (80.3 in.)
Grating period 40 µm
Recommended measuring step 1 µm
(0.000 05 in.)
Reference mark position as required



Mechanical data		**LIDA 190**
Measuring standard		Steel tape scale with AURODUR-grating Grating period 40 µm
Accuracy grades		± 5 µm/± 3 µm (± 0.000 20 in./± 0.000 12 in.)
Reference marks		one at any desired location
Measuring lengths	mm	220/270/320/370/420/470/520/620/720/770/820/920/1020/1240/1440/1640/ 1840/2040
	inch	8.6/10.6/12.6/14.5/16.5/18.5/20.5/24.4/28.3/30.3/32.3/36.2/40.1/48.8/56.7/64.6/ 72.4/80.3
Max. traversing speed		depends on subsequent electronics
Permissible acceleration of scanning head		
Max. vibration (50 ... 2000 Hz)		100 m/s²
Max. shock (11 ms)		500 m/s²
Operating temperature		0 ... 50 °C (32 ... 122 °F)
Storage temperature		–20 ... 70 °C (–4 ... 158 °F)
Weight		Scanning head: 50 g (1.8 oz) Scale: approx. 1.6 kg/m (1.1 lb/ft)
Connecting cable		3 m (10 ft), with connector (standard); 0.3 m (1 ft), with connector on mounting block (special type); 1 m (3.3 ft), without connector (special type)

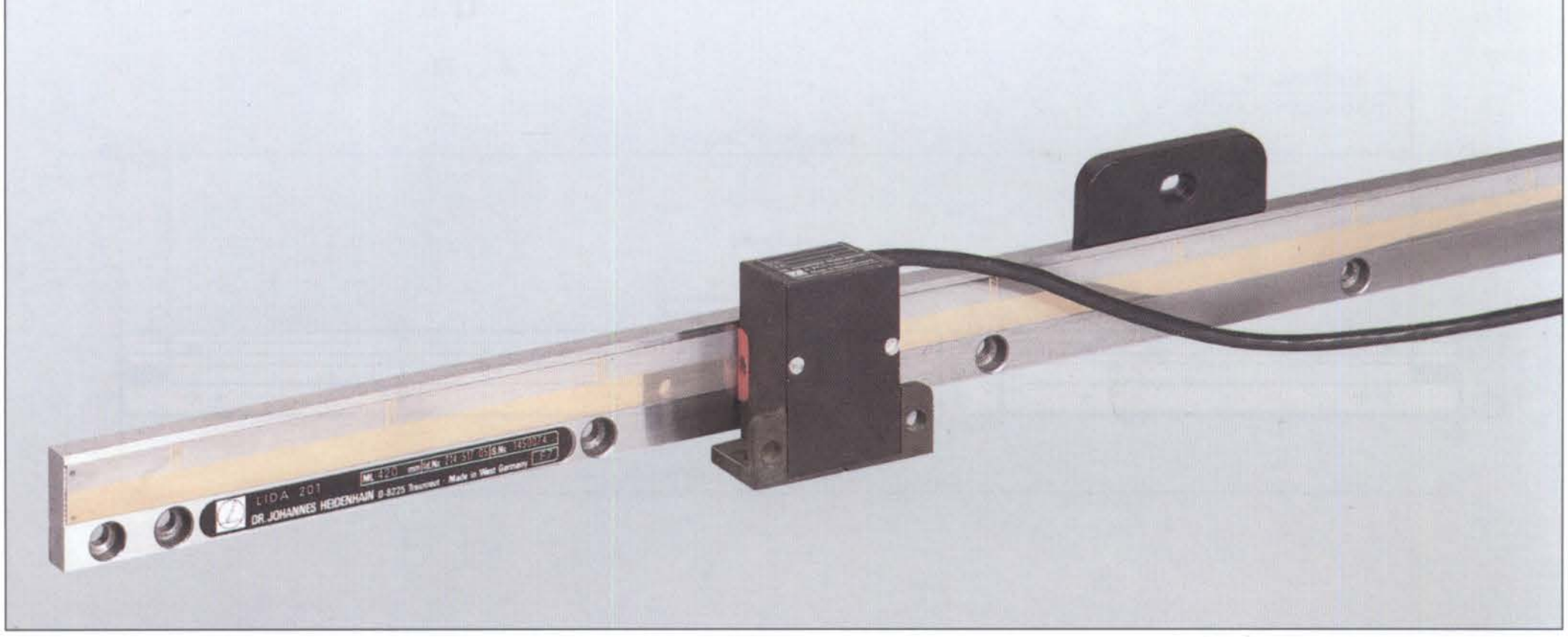
Dimensions in mm (inch)



Electrical data		**LIDA 190**
Light source		LED
Operating voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2}
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 … 16 μA_{pp} I_{e2} approx. 7 … 16 μA_{pp} I_{e0} approx. 2 … 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

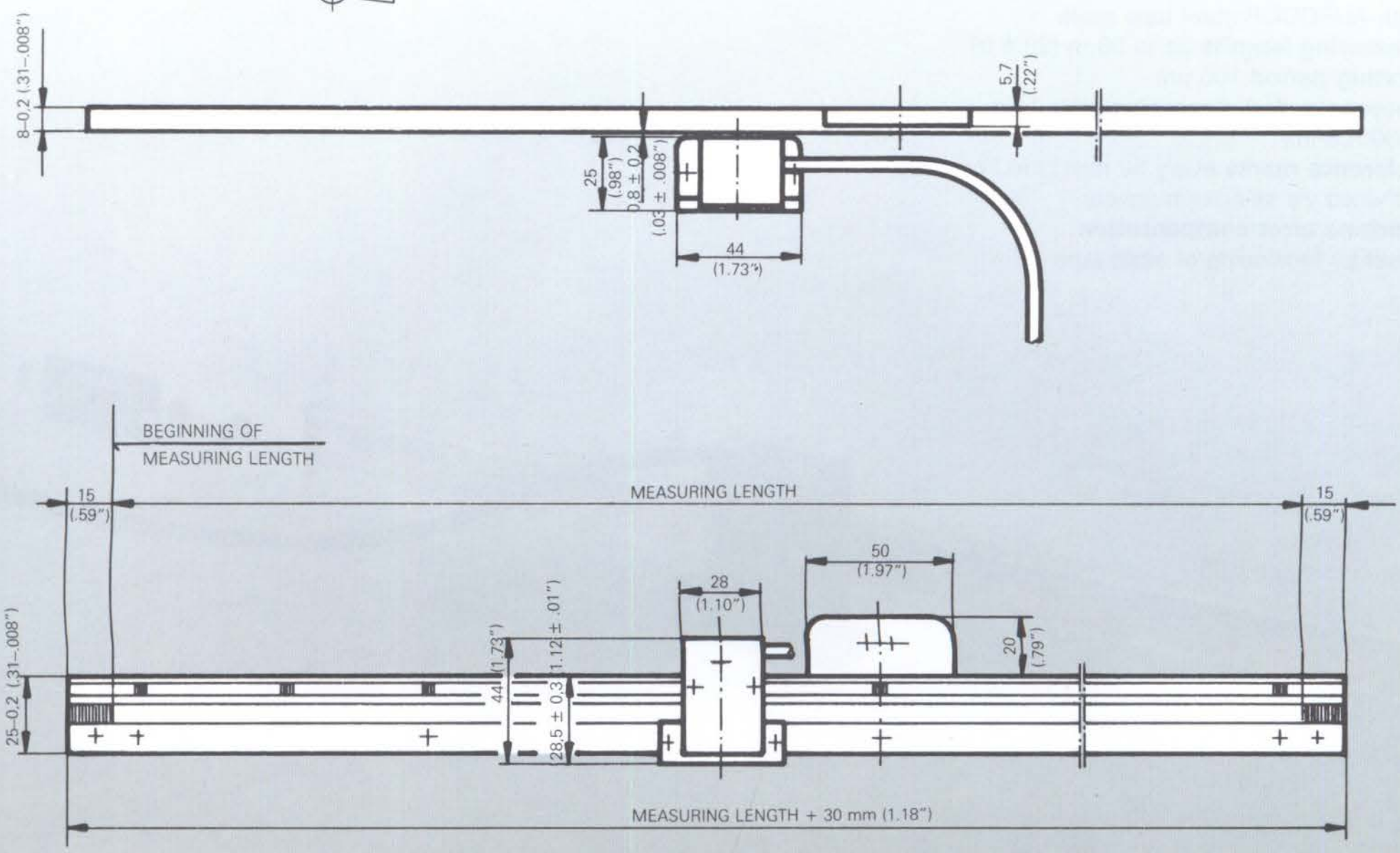
"Exposed" Linear Encoder (reflected light) LIDA 201

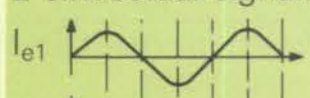
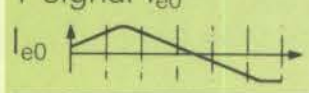
Incremental "exposed" linear encoder
with AURODUR steel scale
Measuring lengths up to 2040 mm (80.3 in.)
Grating period 100 µm
Recommended measuring step 1 µm
(0.000 05 in.)
Reference marks every 50 mm (2 in.) possible,
activated via selector magnets



Mechanical data		**LIDA 201**
Measuring standard		Steel tape scale with AURODUR-grating Grating period 100 µm
Accuracy grades		± 5 µm/± 3 µm (± 0.000 20 in./± 0.000 12 in.)
Reference marks		every 50 mm/2 in. (selector magnets)
Measuring lengths	mm	220/270/320/370/420/470/520/620/720/770/820/920/1020/1240/1440/1640/ 1840/2040
	inch	8.6/10.6/12.6/14.5/16.5/18.5/20.5/24.4/28.3/30.3/32.3/36.2/40.1/48.8/56.7/64.6/ 72.4/80.3
Max. traversing speed		depends on subsequent electronics
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)		 100 m/s² 500 m/s²
Operating temperature		0 ... 50 °C (32 ... 122 °F)
Storage temperature		–20 ... 70 °C (–4 ... 158 °F)
Weight		Scanning head: 50 g (1.8 oz) Selector magnet: 10 g (0.35 oz) Scale: 1,5 kg/m (1.0 lb/ft)
Connecting cable		3 m (10 ft), with connector (standard); 0.3 m (1 ft), with connector on mounting block (special type); 1 m (3.3 ft), without connector (special type)

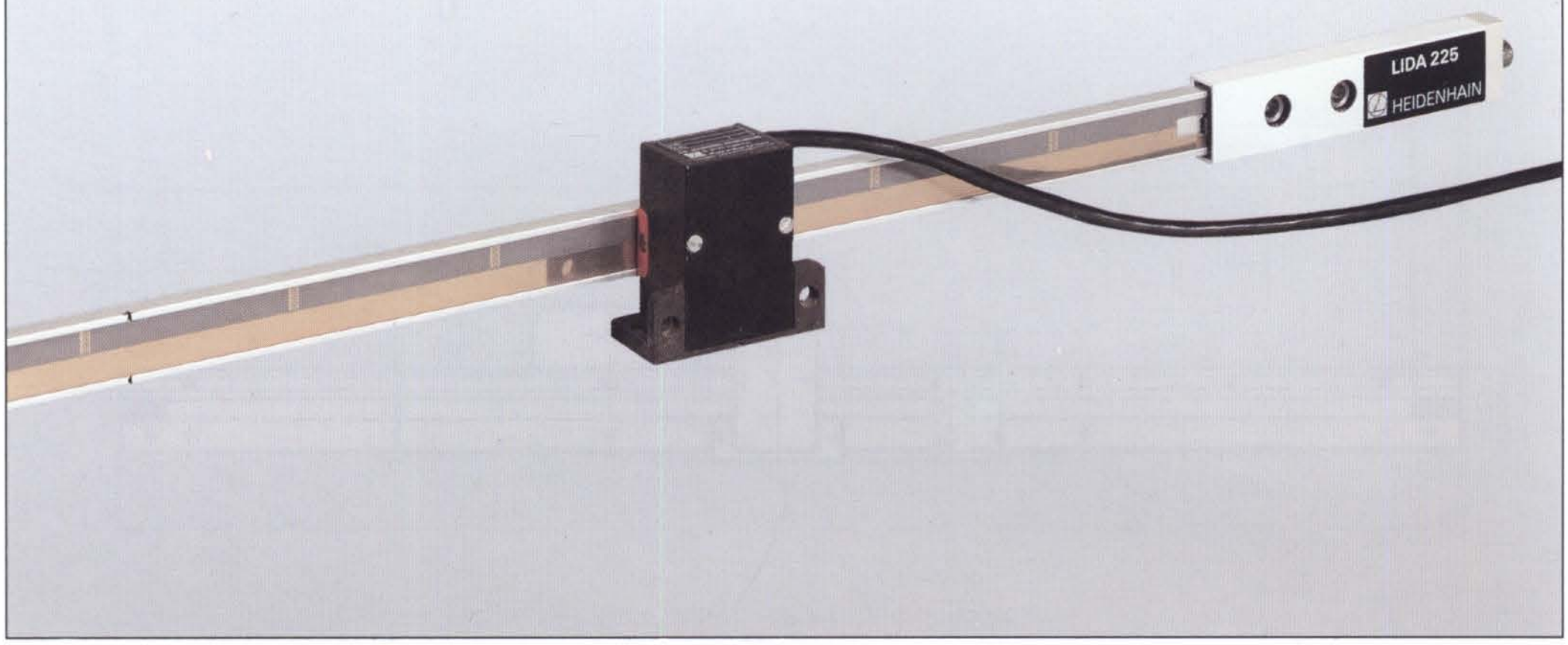
Dimensions in mm (inch)



Electrical data		LIDA 201
Light source		LED
Operating voltage for miniature lamp and switching circuit for reference mark selection		5 V ± 5 %/140 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2}
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

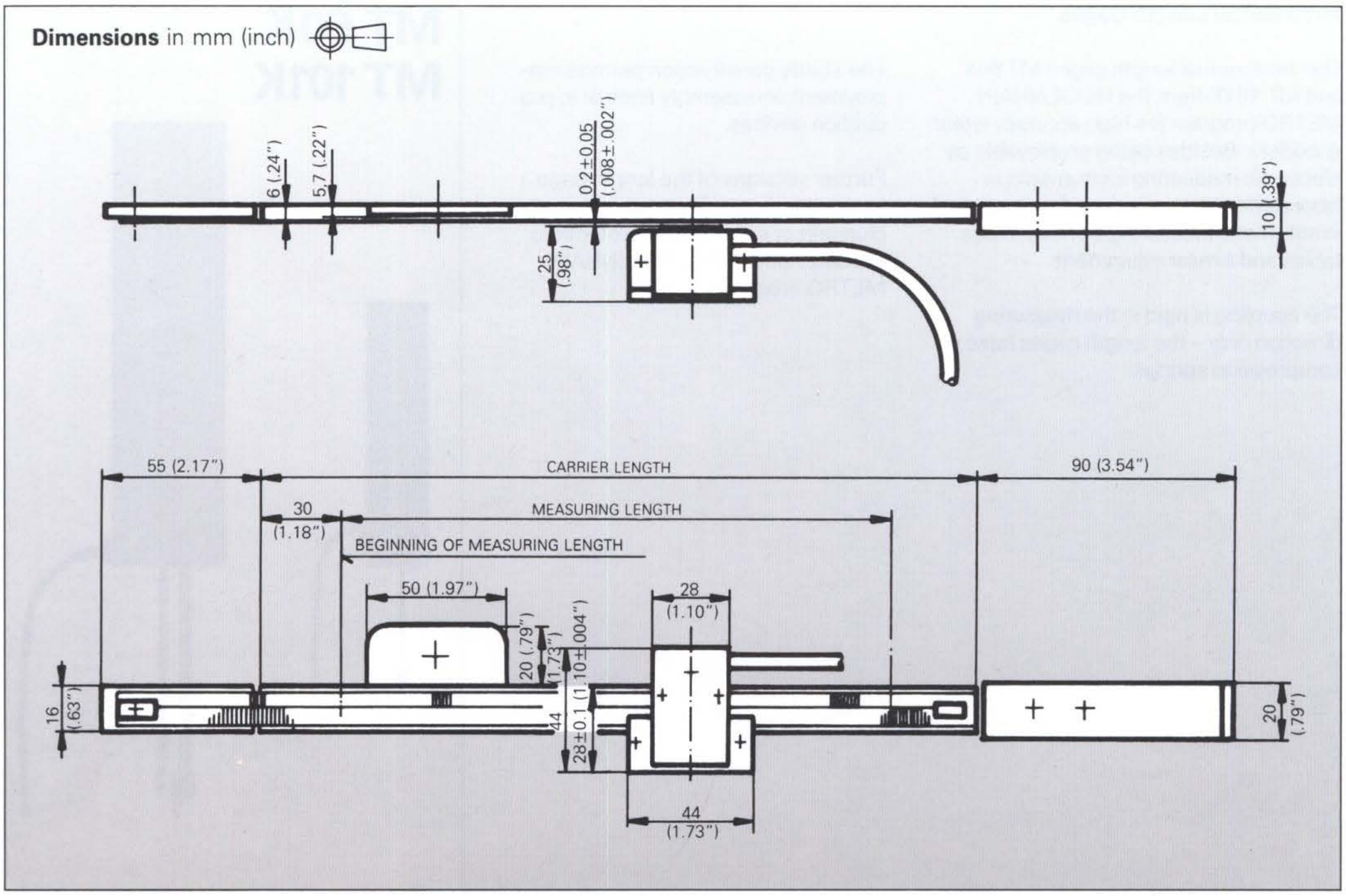
"Exposed" Linear Encoder (reflected light) for large traverses LIDA 225

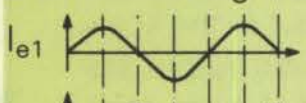
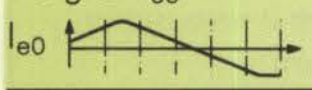
Incremental "exposed" linear encoder
with AURODUR steel tape scale
Measuring lengths up to 30 m (98.4 ft)
Grating period 100 µm
Recommended measuring step 1 µm
(0.000 05 in.)
Reference marks every 50 mm (2 in.) possible,
activated via selector magnets
Machine error compensation
linear by tensioning of scale tape



Mechanical data	**LIDA 225**
Measuring standard	Steel tape scale with AURODUR-grating Grating period 100 µm
Accuracy grade	± 5 µm (± 0.00020 in.)
Machine error compensation	Adjustable, max. ± 100 µm/m (± 100 ppm)
Reference marks	every 50 mm (2 in.) (selector magnets)
Measuring lengths	Assembly kit with single-length AURODUR-scale tape for measuring lengths 140 mm (5.5 in.) to 30 m (98.4 ft) – single-length scale tape carrier (aluminum) for measuring lengths mm 140/240/340/440/540/640/740/840/940/1040/1140/1240/1340/1440/1540/ 1640/1740/1840/1940/2040 inch 5.5/9.5/13.4/17.3/21.3/25.2/29.0/33.0/37.0/41.0/44.9/48.8/52.7/56.7/60.6/ 64.6/68.5/72.4/76.4/80.3 – larger lengths by butting scale tape carrier sections
Max. traversing speed	depends on subsequent electronics
Permissible acceleration Max. vibration (50 ... 2000 Hz) Max. shock (11 ms)	 100 m/s² 500 m/s²
Operating temperature	0 ... 50 °C (32 ... 122 °F)
Storage temperature	–20 ... 70 °C (–4 ... 158 °F)
Weight	Scanning head: 50 g (1,8 oz) Selector magnet: 10 g (0.35 oz) Scale: 100 g + 250 g/m (3.5 oz + 2.7 oz/ft) measuring length
Connecting cable	3 m (10 ft), with connector (standard); 0.3 m (1 ft), with connector on mounting block (special type); 1 m (3.3 ft), without connector (special type)

Dimensions in mm (inch)



Electrical data		LIDA 225
Light source		LED
Operating voltage for miniature lamp and switching circuit for reference mark selection		5 V ± 5 %/140 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2}
	Reference signal	1 signal I_{e0} I_{e0} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)
Total permissible cable length		20 m (65.6 ft)

Special Linear Encoders

Incremental Length Gages

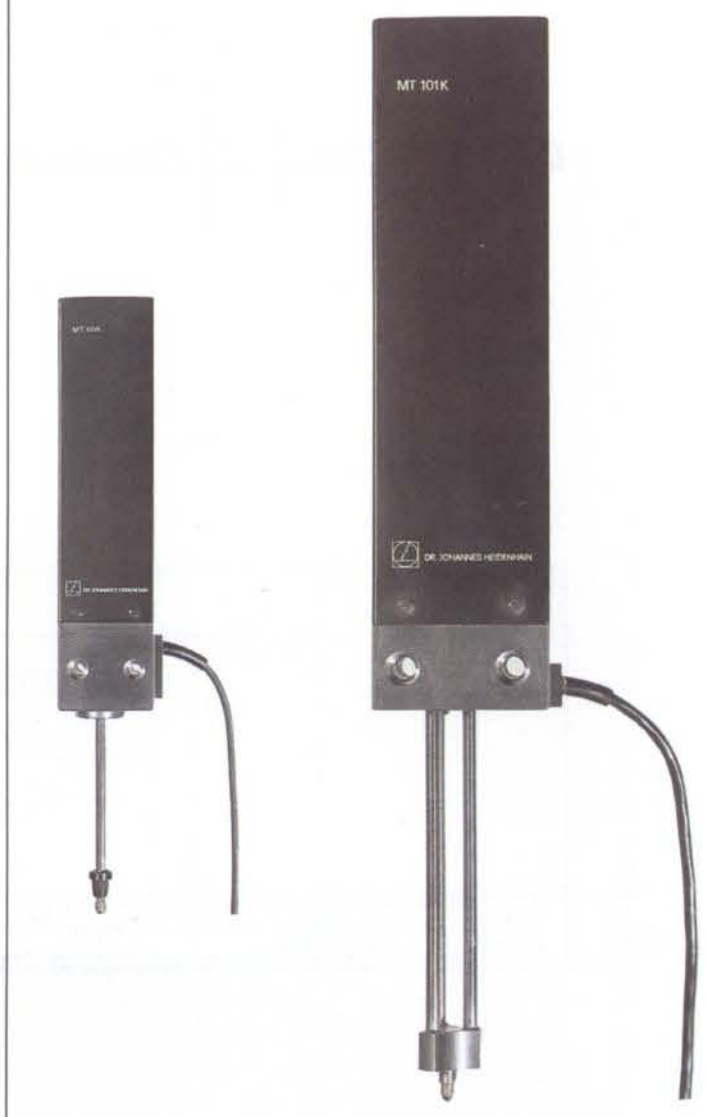
The incremental length gages MT 60K and MT 101K from the HEIDENHAIN METRO program are high-accuracy linear encoders. Besides being employable as electronic measuring instruments in laboratories, they can operate just as well in automatic measuring devices, cross tables and similar equipment.

The coupling is rigid in the measuring direction only – the length gages have no compression springs.

The sturdy construction permits employment on assembly lines or in production devices.

Further versions of the length gage (e. g. with motor-driven or pneumatic plungers or splashwater protection) are described in the HEIDENHAIN METRO brochure.

MT 60K
MT 101K



Comparator System

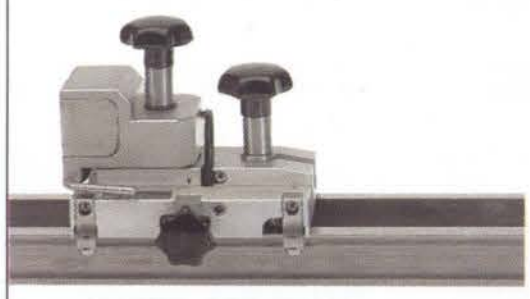
The VM 101 comparator system is an exposed incremental linear encoder with very high measuring accuracy. It serves primarily as a reference measuring system for calibrating small machine tools. It is also suited, however, for determining position errors on cross tables (e. g. PCB drilling machines) or testing equipment.

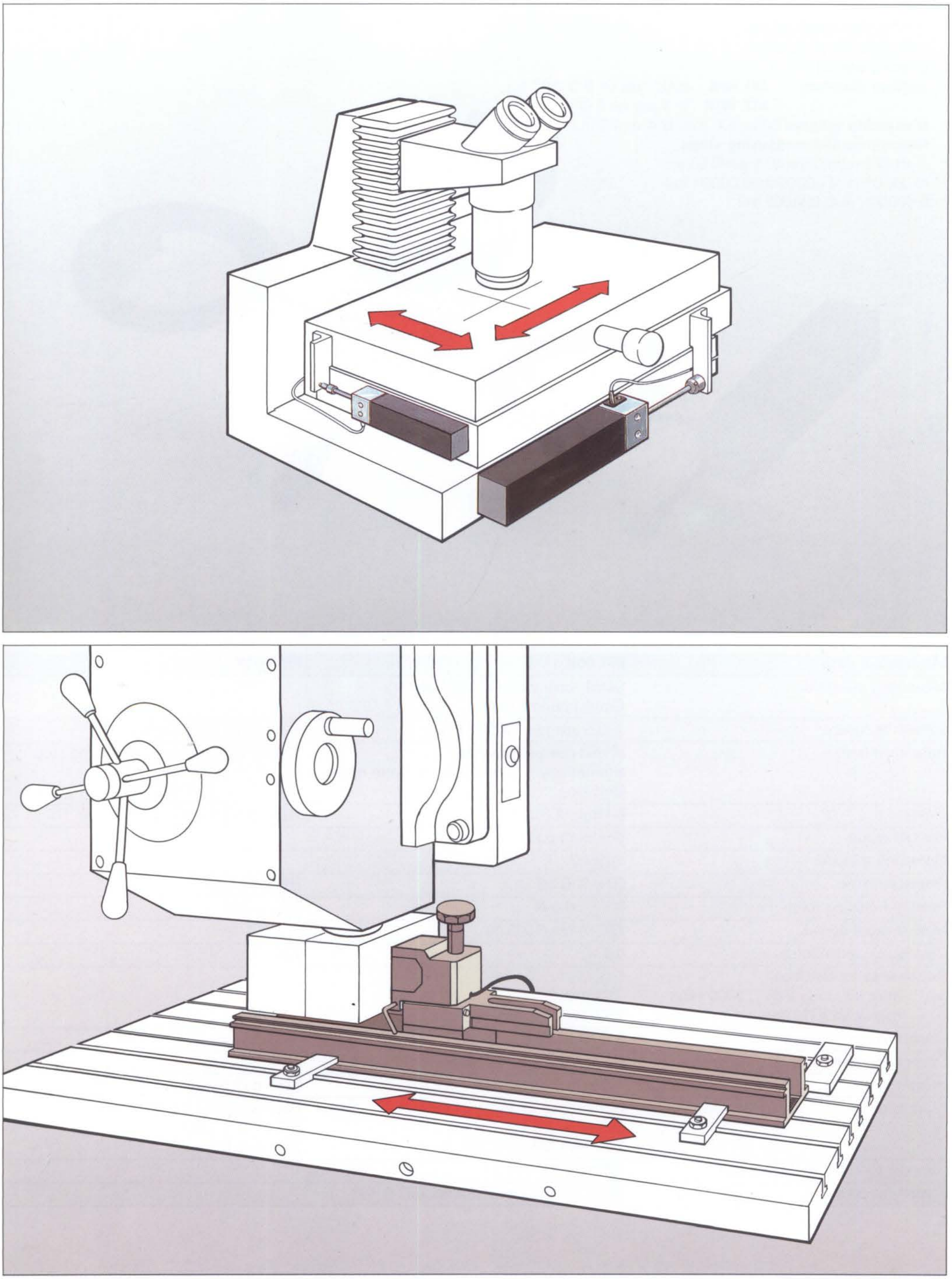
The VM 101 consists of the scale carrier with a precision scale, the scanning unit, an auxiliary carriage for set up and an interface electronics. The sturdy **scale carrier** is constructed of stainless steel in the shape of a U beam. The measuring standard – a precision scale with a phase grating graduation, grating period 8 µm – is mounted on the neutral stress zone of the U beam. A glass lamella secured with cement protects the grating from contamination.

The **scanning unit** runs along the scale without making mechanical contact.

The **interface electronics** – electrically adjusted to the scanning unit by HEIDENHAIN – forms out of the scanning signals two sinusoidal output signals with a signal period of 4 µm, phase-shifted to one another by 90° el. The small signal period and the high scale accuracy of ± 1 µm permit measuring steps as small as 0.02 µm.
Relatively large installation tolerances simplify mounting and adjustment.

VM 101



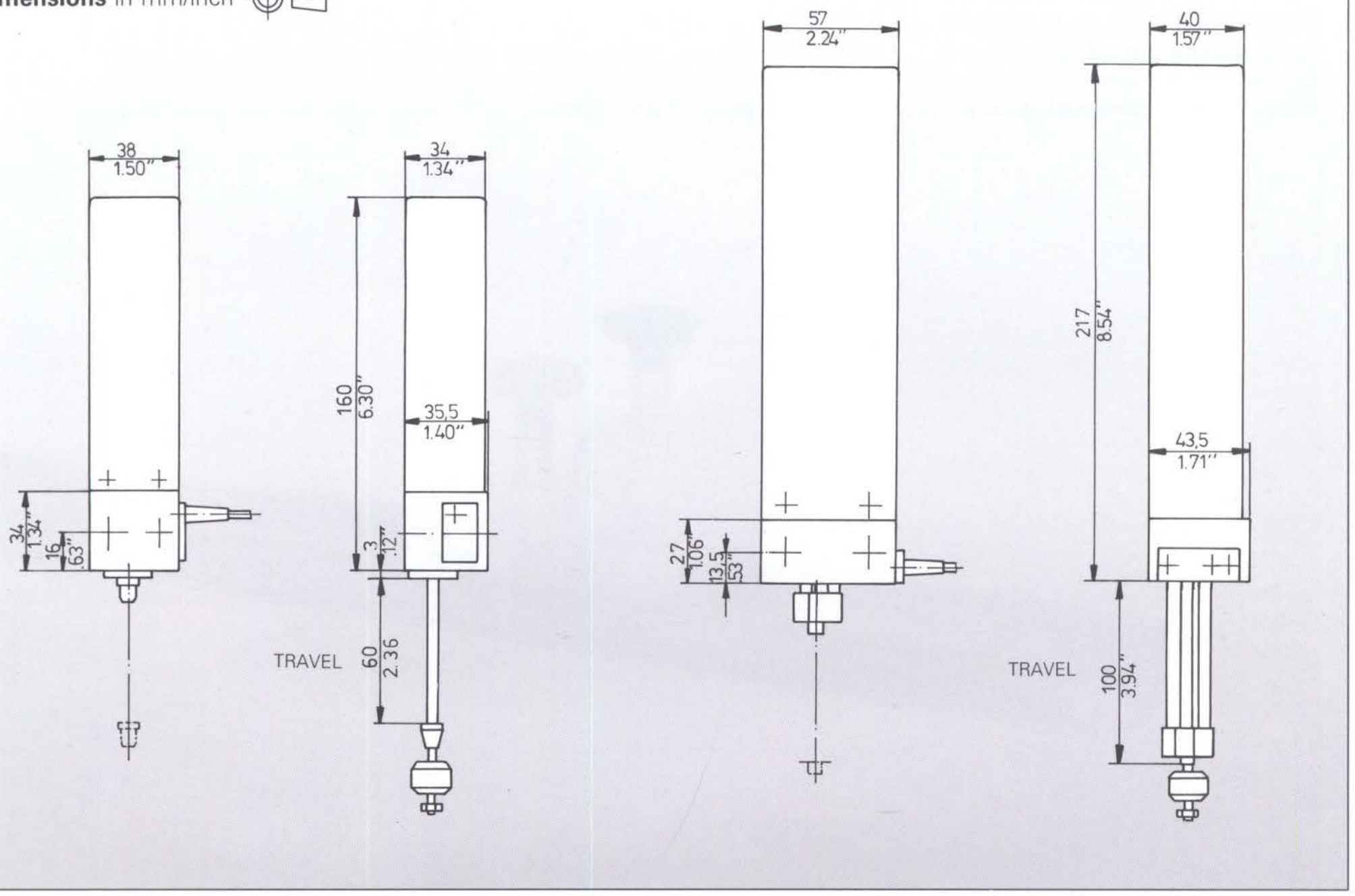


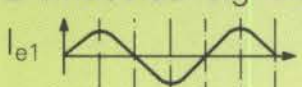
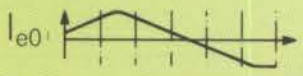
Incremental Length Gages MT 60K/MT 101K

Incremental length gages
with DIADUR glass scale
Grating period 10 µm
System accuracy **MT 60K** ± 0,5 µm (± 0.00002 in.)
MT 101K ± 1 µm (± 0.00004 in.)
Measuring lengths 60 or 100 mm (2.4 or 4.0 in.)
Recommended measuring steps
1 µm/0.5 µm/0.2 µm/0.1 µm/0.05 µm
(0.00005 in./0.00002 in./0.00001 in./
0.000005 in./0.000002 in.)

Mechanical data	MT 60K	MT 101K
Measuring standard	Glass scale with DIADUR-grating Grating period 10 µm	
System accuracy	± 0,5 µm (± 0.00002 in.)	± 1 µm (± 0.00004 in.)
Reference marks	at mid-point of traverse; alternatively 1.5 mm (0.06 in.) from upper limit stop	10 mm (0.4 in.) from upper limit stop
Travel	60 mm (2.3 in.)	100 mm (3.9 in.)
Plunger guide	Ball-bush guide	
Operating attitude	optional	
Displaced mass	50 g (1.8 oz)	165 g (5.8 oz)
Required moving force	0.1 ... 0.6 N	0.5 ... 2 N
Max. plunger speed	250 mm/s (10 in./s)	
Permissible radial force	0.5 N	2 N
Permissible acceleration max. vibration (50 ... 2000 Hz) max. shock (11 ms)	 100 m/s² 1000 m/s²	
Operating temperature	0 ... 50°C (32 ... 122°F)	
Storage temperatur	–20 ... 70°C (–4 ... 158°F)	
Weight	700 g (1.5 lb)	1200 g (2.6 lb)
Mounting	Flat surface 38 mm×34 mm (1.5 in. × 1.3 in.), 2 screws M5	Flat surface 57 mm×27 mm (2.2 in. × 1.1 in.), 2 screws M8
Connecting cable to display unit	1.5 m (5 ft)	
Thread for coupling	M2.5 (6 mm/0.24 in. deep) ISO/R 463	

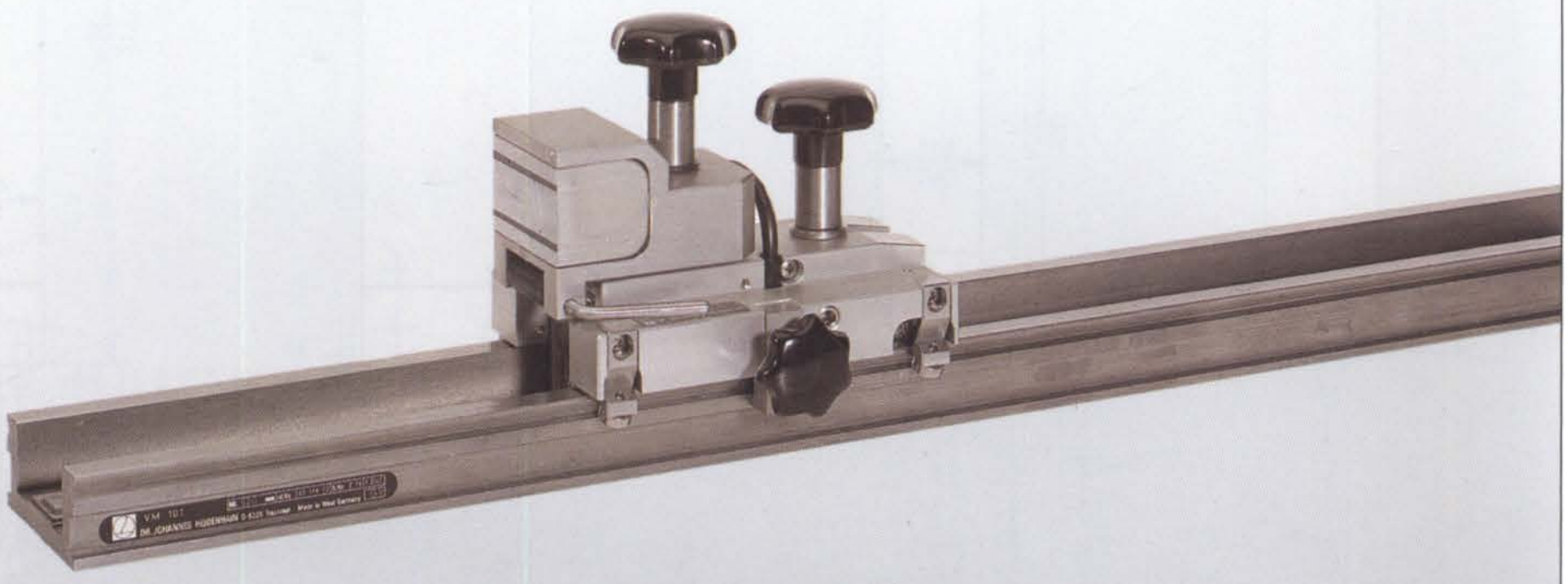
Dimensions in mm/inch



Electrical data		**MT 60K**	**MT 101K**
Light source		Miniature lamp 5/0.6 W	LED
Operating voltage		5 V ± 5 %/120 mA	
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} I_{e1}  I_{e2} 	
	Reference signal	1 signal I_{e0} I_{e0} 	
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp} I_{e0} approx. 2 ... 8 µA (usable portion)	
Total permissible cable length		20 m (65.6 ft)	

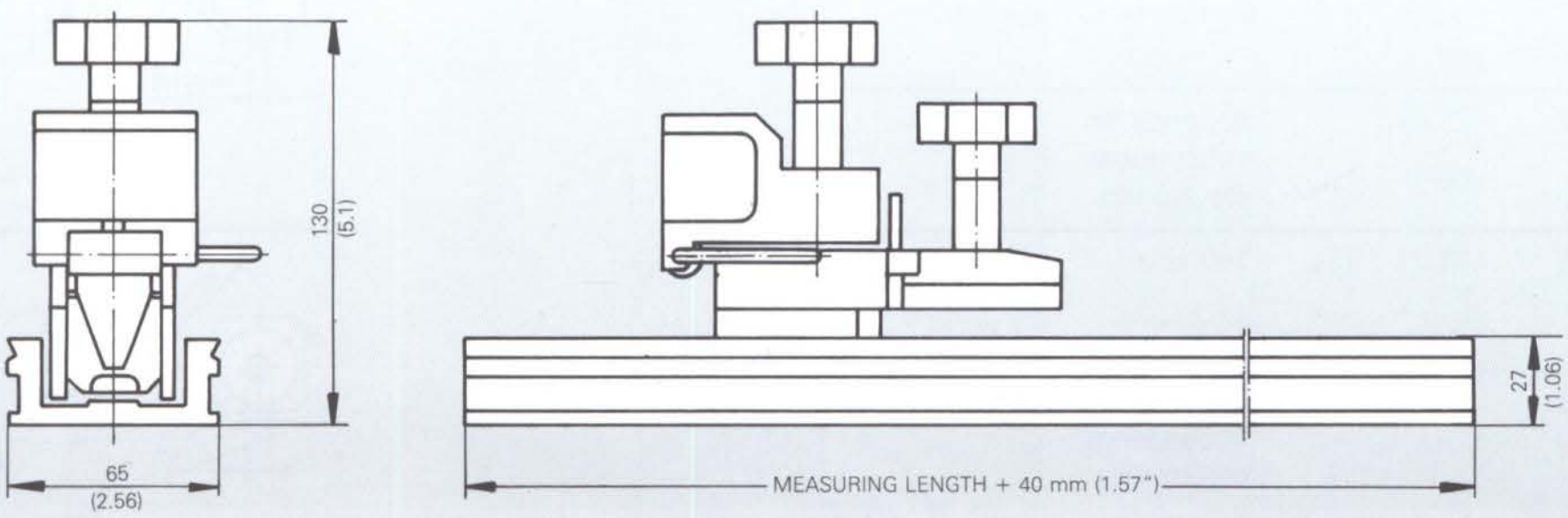
Incremental Comparator System VM 101

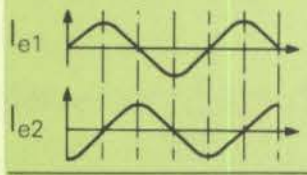
Incremental "exposed" comparator system
Measuring lengths up to 1020 mm (40.1 in.)
Scale grating period 8 µm
Signal period 4 µm
Recommended measuring steps 1 µm/0.2 µm/0.1 µm/0.02 µm (0.00005 in./0.00001 in./0.000005 in./0.000001 in.)



Mechanical data	**VM 101**
Measuring standard	Phase grating without reference mark Scale grating period 8 µm Signal period 4 µm
Accuracy grade	± 1 µm (±0.00004 in.)
Measuring lengths	420/520/1020 mm (16.5/20.5/40.1 in.)
Max. traversing speed	depends on subsequent electronics
Permissible acceleration max. vibration (50 ... 2000 Hz) max. shock (11 ms)	 5 m/s² 10 m/s²
Operating temperature	10 ... 30°C (50 ... 86°F)
Storage temperature	–20 ... 50°C (–4 ... 122°F)
Weigth	Scanning unit: approx. 1.2 kg (2.64 lb.) Scale: approx. 6.5 kg/m (4.36 lb./in.) APE 101 interface electronics: 0.3 kg (0.66 lb.)
Connecting cable	0.5 m (1.64 ft.) between scanning unit and APE flange socket (9-pole) on APE

Dimensions in mm (inch)

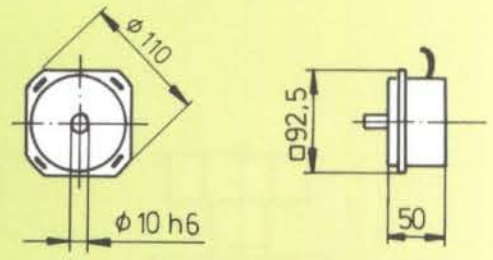
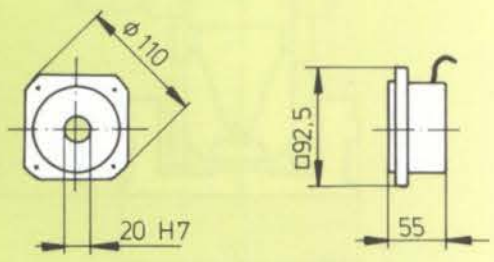


Electrical data		VM 101
Light source		LED
Supply voltage		5 V ± 5 %/120 mA
Output signals	Incremental signals	2 sinusoidal signals I_{e1} and I_{e2} 
	Signal levels with 1 kΩ load	I_{e1} approx. 7 ... 16 μA_{pp} I_{e2} approx. 7 ... 16 μA_{pp}
Total permissible cable length		20 m (65.6 ft.)

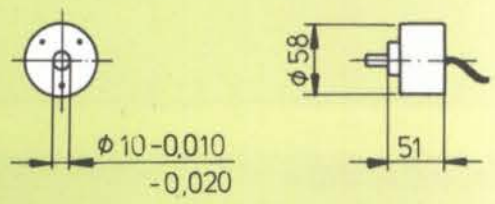
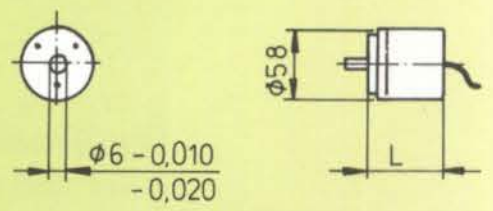
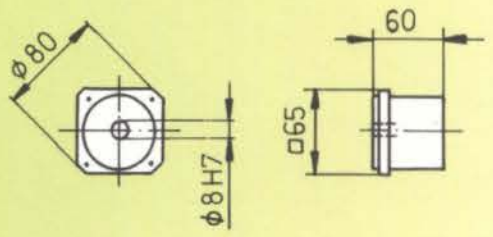
HEIDENHAIN Rotary Encoders

In conjunction with a rack and pinion or lead screw as measuring standard, incremental rotary encoders can also be employed for linear measuring applications i.e. determination of lengths or traverses.

ROD 100/RON 100 Series

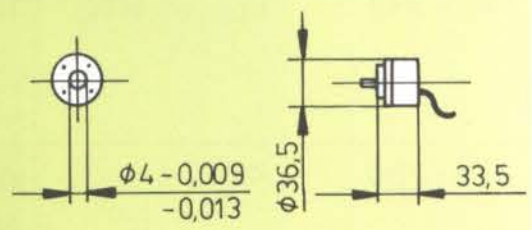
Model	Output signals	max. scanning frequency	Operating voltage	Line numbers	Overall dimensions in mm
ROD 121	⊓⊔ TTL	100 kHz	5 V	360/400/500/512/600/720/800/900/1000/1024/1156/1250/1500/1800/2000/2048/2080/2500/3600/4096/5000	
ROD 131	⊓⊔ HTL	100 kHz	10 . . . 16 V		
ROD 151	∿	depends on subsequent electronics	5 V		
RON 125	⊓⊔ TTL	160 kHz	5 V		
RON 155	∿	depends on subsequent electronics	5 V		

ROD 400/RON 400 Series

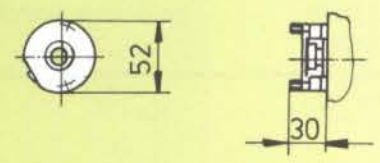
Model	Output signals	max. scanning frequency	Operating voltage	Line numbers	Overall dimensions in mm
ROD 420	⊓⊔ TTL	160 kHz	5 V	50/60/100/120/125/128/150/180/200/250/254/256/360/400/420/500/512/600/625/635/720/800/900/1000/1024/1080/1125/1250/1270/1500/1750/1800/2000/2048/2500/2540/3000/3600/3750/4096/4500/5000	
ROD 450	∿	depends on subsequent electronics	5 V		
ROD 426 A	⊓⊔ TTL	300 kHz	5 V		
ROD 426 E	⊓⊔ TTL	160 kHz	5 V	ROD 426 E: up to 3600	
ROD 428	⊓⊔ TTL (with fault detection signal)	300 kHz	5 V		
ROD 436	⊓⊔ HTL	75 kHz	10 . . . 16 V		
ROD 446	⊓⊔ HTL, 24 V	100 kHz	15 . . . 29 V		
ROD 456	∿	depends on subsequent electronics	5 V		
RON 425	⊓⊔ TTL	160 kHz	5 V		
RON 455	∿	depends on subsequent electronics	5 V		

Length L	Type
72	ROD 426 A/ROD 428/ ROD 436/ROD 446
56	ROD 426 E
63	ROD 456

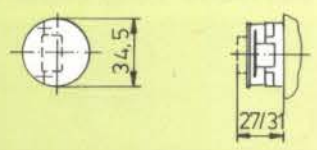
MINIROD 400 Series

Model	Output signals	max. scanning frequency	Operating voltage	Line numbers	Overall dimensions in mm
MINIROD 420	⊓⊔ TTL	160 kHz	5 V	100/200/250/360/500/600/ 720/900/1000/1024/1080/ 1250/1500/2000/2500/3600	
MINIROD 450	∿	depends on subsequent electronics	5 V		

ERO 1200 Series

Model	Output signals	max. scanning frequency	Operating voltage	Line numbers	Overall dimensions in mm
ERO 1221	⊓⊔ TTL	100 kHz	5 V	50/60/100/120/125/128/150/ 180/200/250/254/256/360/ 400/420/500/512/600/625/ 635/720/800/900/1000/1024/ 1080/1125/1250/1270/1500/ 1800/2000/2048/2080/2500	 Hub inside diameter 4/6/8/10 mm
ERO 1251	∿	depends on subsequent electronics	5 V		

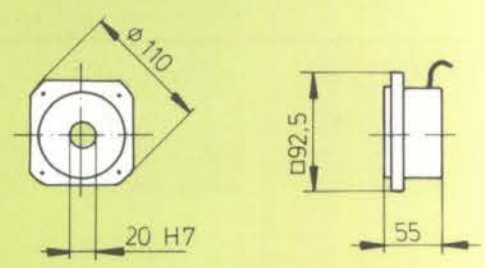
ERO 1400 Series

Model	Output signals	max. scanning frequency	Operating voltage	Line numbers	Overall dimensions in mm
ERO 1420	⊓⊔ TTL	160 kHz	5 V	100/200/250/360/500/600/ 720/900/1000/1024/1080/ 1250/1500	
ERO 1450	∿	depends on subsequent electronics	5 V		

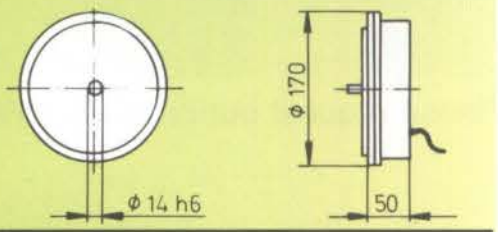
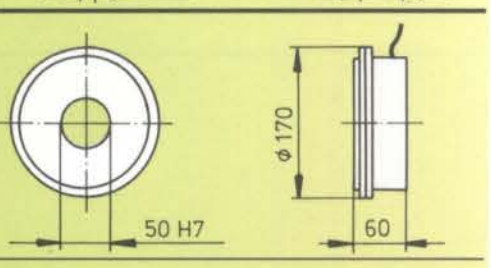
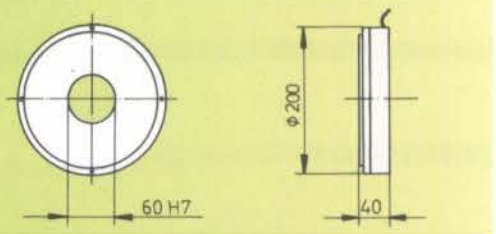
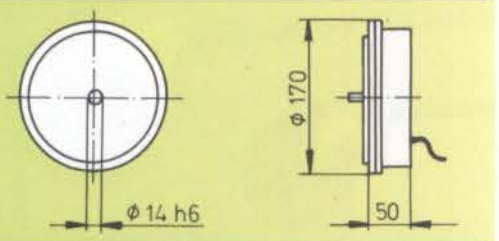
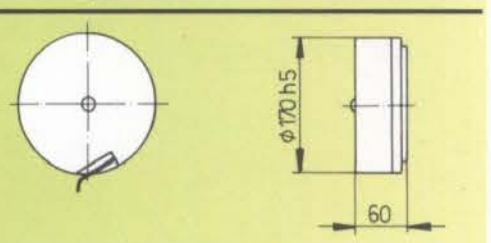
Please request our brochure "Rotary Encoders".

HEIDENHAIN Angle Encoders

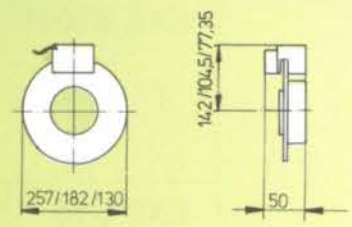
ROD 200/RON 200 Series

Model	Output signals	max. scanning frequency	Operating voltage	Line numbers/Accuracy	Overall dimensions in mm
ROD 230	⊓⊔ HTL	100 kHz	10 . . . 16 V	6000 / ± 10" 7854 / ± 9" 8192 / ± 8" 9000 / ± 7" 10000 / ± 6" 10800 / ± 6" 12500 / ± 5" 16384 / ± 5" 18000 / ± 5"	
ROD 250	∿	depends on subsequent electronics	5 V		
ROD 260	⊓⊔ TTL	1 MHz	5 V		
ROD 271 (integrated 5fold interpolation)	⊓⊔ TTL (with fault detection signal)	25 kHz	5 V		
RON 255	∿	depends on subsequent electronics	5 V		
RON 275 (integrated 5fold interpolation)	⊓⊔ TTL (with fault detection signal)	25 kHz	5 V		

ROD 700/RON 700, ROD 800 and RON 900 Series

Model	Output signals	max. scanning frequency	Operating voltage	Line numbers/Accuracy	Overall dimensions in mm
ROD 700	∿	depends on subsequent electronics	5 V	9000 / ± 5" 18000 / ± 2,5" 25920 / ± 2,5" 32400 / ± 2,5" 36000 / ± 2"	
RON 705	∿	depends on subsequent electronics	5 V	9000 / ± 5" 18000 / ± 2,5"	
RON 706	∿	depends on subsequent electronics	5 V	18000 / ± 2,5"	
ROD 800	∿	depends on subsequent electronics	5 V	18000 / ± 1" 25920 / ± 1" 36000 / ± 1"	
RON 905	∿	depends on subsequent electronics	5 V	36000 / ± 0,2"	

ERO 700 Series

Model	Output signals	max. scanning frequency	Operating voltage	Line numbers/Accuracy	Overall dimensions in mm
ERO 725	~	depends on subsequent electronics	5 V	9000/18000/36000 Factors to be considered for assessing measuring accuracy are errors from imperfect centering and bearing errors.	

Please request our brochure „Rotary Encoders"

ROD 200/RON 200 Series

ROD 700/ROD 800

RON 705

RON 706

RON 905

ERO 725

Recommended Combination of Linear Encoder and EXE –

Encoder inputs	Model	Interpolation	Maximum input frequency	Output signals per axis	Line driver	Supply voltage
1	**EXE 602 D**	without 5-fold	50 kHz 25 kHz	1TTL ⊓⊔	MC 3487	5 V
	EXE 610 B	10-fold	25 kHz	1TTL ⊓⊔	MC 3487	5 V
	EXE 630	without 4-fold 5-fold	50 kHz 30 kHz 25 kHz	1HTL ⊓⊔	MC 3487	10 . . . 16 V
	EXE 650	50-fold or 25-fold selectable	43 kHz	1TTL ⊓⊔	MC 3487	5 V
	EXE 702	25-fold	15 kHz	1 TTL ⊓⊔	SN 75113 SN 75114	100 . . . 240 V~ integral power supply unit
	EXE 816	25-fold	10 kHz	2 TTL ⊓⊔	SN 75114	115/220 V~ integral power supply unit
2	**EXE 801**	without or 5-fold selectable	50 or 25 kHz	2 TTL ⊓⊔	SN 75114	115/220 V~ integral power supply unit
	EXE 804	without or 5-fold selectable additionally without	50 or 25 kHz 50 kHz	1 TTL ⊓⊔ 1 ~	SN 75114	115/220 V~ integral power supply unit
	EXE 808	25-fold	15 kHz	2 TTL ⊓⊔	SN 75114	115/220 V~ integral power supply unit
3	**EXE 802**	without or 5-fold selectable	50 or 25 kHz	2 TTL ⊓⊔	SN 75114	115/220 V~ integral power supply unit
	EXE 805	without or 5-fold selectable additionally without	50 or 25 kHz 50 kHz	1 TTL ⊓⊔ 1 ~	SN 75114	115/220 V~ integral power supply unit
	EXE 837	Axis 1: 25-fold Axis 2: 5-fold Axis 3: 5-fold	15 kHz 25 kHz 25 kHz	2 TTL ⊓⊔	MC 3487	100 . . . 240 V~ integral power supply unit
	EXE 838	Axis 1: 25-fold Axis 2: 25-fold Axis 3: 5-fold	15 kHz 15 kHz 25 kHz	2 TTL ⊓⊔	MC 3487	100 . . . 240 V~ integral power supply unit
	EXE 839	Axis 1: 25-fold Axis 2: 25-fold Axis 3: 25-fold	15 kHz 15 kHz 15 kHz	2 TTL ⊓⊔	MC 3487	100 . . . 240 V~ integral power supply unit

Measuring Steps

LS 101, 101 C LID 311, 311 C LID 351, 351 C MT 60, MT 101	LS 107, 107 C LS 403, 403 C LS 404, 404 C LS 704, 704 C ULS 300, 300 C	LIDA 190	LIDA 201 LIDA 225 LB 326	LIP 101
0.5 µm 1 µm (0.00002 in. 0.00005 in.)	1 µm (0.00005 in.)	2 µm 10 µm (0.0001 in. 0.0005 in.)	5 µm 10 µm (0.0002 in. 0.0005 in.)	0.2 µm (0.00001 in.)
0.5 µm (0.00002 in.)	0.5 µm (0.00002 in.)	1 µm (0.00005 in.)	5 µm (0.00020 in.)	0.1 µm 0.2 µm (0.000005 in. 0.00001 in.)
0.5 µm 1 µm (0.00002 in. 0.00005 in.)	1 µm 2 µm (0.00005 in. 0.0001 in.)	1 µm 2 µm (0.00005 in. 0.0001 in.)	5 µm 10 µm (0.0002 in. 0.0005 in.)	0.2 µm 0.5 µm (0.00001 in. 0.00002 in.)
0.05 µm 0.1 µm (0.000002 in. 0.000005 in.)	0.1 µm (0.000005 in.)	0.2 µm (0.00001 in.)	0.5 µm 1 µm (0.00002 in. 0.00005 in.)	0.02 µm (0.000001 in.)
0 µm 0.2 µm (0.000005 in. 0.00001 in.)	0.2 µm (0.00001 in.)	–	1 µm 2 µm (0.00005 in. 0.0001 in.)	–
0.1 µm 0.2 µm (0.000005 in. 0.00001 in.)	0.2 µm (0.00001 in.)	–	1 µm 2 µm (0.00005 in. 0.0001 in.)	–
0.5 µm 1 µm (0.00002 in. 0.00005 in.)	1 µm (0.00005 in.)	2 µm 10 µm (0.0001 in. 0.0005 in.)	5 µm 10 µm (0.0002 in. 0.0005 in.)	0.2 µm (0.00001 in.)
0.5 µm 1 µm (0.00002 in. 0.00005 in.)	1 µm (0.00005 in.)	2 µm 10 µm (0.0001 in. 0.0005 in.)	5 µm 10 µm (0.0002 in. 0.0005 in.)	0,2 µm (0.00001 in.)
0.1 µm 0.2 µm (0.000005 in. 0.00001 in.)	0.2 µm (0.00001 in.)	–	1 µm 2 µm (0.00005 in. 0.0001 in.)	–
0.5 µm 1 µm (0.00002 in. 0.00005 in.)	1 µm (0.00005 in.)	2 µm 10 µm (0.0001 in. 0.0005 in.)	5 µm 10 µm (0.0002 in. 0.0005 in.)	0.2 µm (0.00001 in.)
0.5 µm 1 µm (0.00002 in. 0.00005 in.)	1 µm (0.00005 in.)	2 µm 10 µm (0.0001 in. 0.0005 in.)	5 µm 10 µm (0.0002 in. 0.0005 in.)	0.2 µm (0.00001 in.)
A1: 0.1 µm (0.000005 in.) A2: 0.5 µm/1 µm (0.00002 in./0.00005 in.) A3: 0.5 µm/1 µm (0.00002 in./0.00005 in.)	A1: 0.2 µm (0.00001 in.) A2: 1 µm (0.00005 in.) A3: 1 µm (0.00005 in.)	A1: – A2: 2 µm (0.0001 in.) A3: 2 µm (0.0001 in.)	A1: 1 µm/2 µm (0.00005 in./0.0001 in.) A2: 5 µm/10 µm (0.0002 in./0.0005 in.) A3: 5 µm/10 µm (0.0002 in./0.0005 in.)	–
A1: 0.1 µm (0.000005 in.) A2: 0.1 µm (0.000005 in.) A3: 0.5 µm/1 µm (0.00002 in./0.00005 in.)	A1: 0.2 µm (0.00001 in.) A2: 0.2 µm (0.00001 in.) A3: 1 µm (0.00005 in.)	A1: – A2: – A3: 2 µm (0.0001 in.)	A1: 1 µm/2 µm (0.00005 in./0.0001 in.) A2: 1 µm/2 µm (0.00005 in./0.0001 in.) A3: 5 µm/10 µm (0.0002 in./0.0005 in.)	–
0.1 µm (0.000005 in.)	0.2 µm (0.00001 in.)	–	1 µm 2 µm (0.00005 in./ 0.0001 in.)	–

EXE 600 Series
Height 57 mm (2.24 in.)
Width 80 mm (3.15 in.)
Depth 175 mm (6.89 in.)

EXE 700 Series
Height 82 mm (3.23 in.)
Width 262 mm (10.31 in.)
Depth 263 mm (10.35 in.)

EXE 800 Series
Height 115 mm (4.53 in.)
Width 280 mm (11.02 in.)
Depth 270 mm (10.63 in.)

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